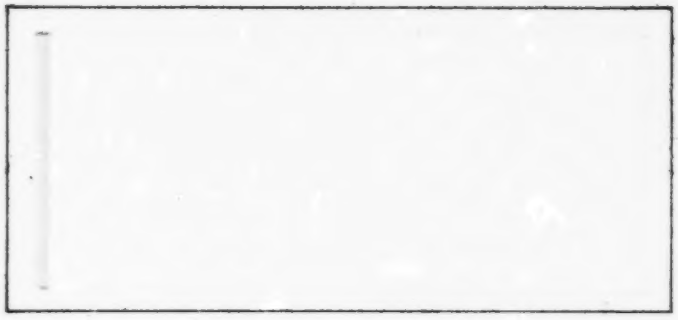
RESEARCH REPORT



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CTOD TESTING OF SMAW AND SAW SPECIMENS

Contract Serial OSQ85-00173

Welding Institute of Canada Report RC286/2/86

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1.0 Introduction

This report summarizes the results of crack tip opening displacement (CTOD) testing of two separate shipments of machined specimens. Initially, 147 (t x 2t) CTOD specimens, nominal dimensions of 20 mm x 40 mm, which had been prepared from twenty shielded metal arc weldments were supplied by CANMET. Each specimen was notched and precompressed to one percent strain before being sent to the Welding Institute of Canada for testing at temperatures of -10°C and -30°C. Fifty-eight of the CTOD specimens had already been prefatigued at PMRL to a/W values of 0.50.

An additional shipment of 107 (tx2t, 20 x 40 mm) CTOD specimens made from submerged arc weldments and supplied by CANMET in the fatigue precracked condition were also tested.

The results of testing both the shielded metal arc and submerged arc specimens are summarized in this report.

2.0 Test Results

The CTOD tests were conducted in accordance with BS5762:1979, Methods for Crack Opening Displacement (COD) testing, at -10°C and -30°C. These temperatures were achieved using an environmental chamber surrounding the specimen into which was pumped liquid nitrogen vapour. Thermocouples were placed in holes drilled through the ends of the specimens to ensure that the desired temperature was maintained for at least 10 minutes prior to loading.

The load/clip gauge displacement curves (see Appendix A) indicated that these welds exhibited a range of fracture behaviour from brittle to fully ductile over the temperature range tested.

Several of the welds exhibited 'pop-ins' during loading, with some of them

occurring on the linear portion of the load/displacement graph. Continued loading resulted in failure of the specimen in the mixed elastic/plastic regime, sometimes with up to three additional 'pop-ins'. When more than two 'pop-ins' were observed, only the first and last load drop point were reported for the CTOD values.

Notch lengths were measured at the three positions shown in Figure 1 after CTOD testing and were used to calculate the average crack length, a.

The reported weld metal yield strengths, listed in Table 1, were used in conjunction with the clip gauge displacements to calculate the relevant crack tip opening displacement, δ, using the following relationship:

$$\delta = [K^2(1 - \nu^2)]/(2\sigma_y E) + [0.4(W - a)\, V_p]/(0.4W + 0.6a + Z)$$

where $K = (YP)/(BW^{0.5})$ and P and V_p are the force and plastic component of clip gauge opening displacement, respectively. The CTOD values are included in Table 2.

If failure occurred close to the linear range, the secant offset procedure was applied to determine the fracture type (a 5° secant overlay was used on the load-displacement curves). The fracture types (δ_c, δ_u or δ_m) are noted in the last column of Table 2. A brief description of the types is as follows:

δ_c Crack opening displacement at either:
a) unstable fracture, or
b) onset of arrested brittle crack or pop-in.
This term only applies where there <u>is no evidence</u> in either a) or b) to suggest that slow crack growth has occurred.

δ_u Crack opening displacement at either:
a) unstable fracture, or
b) onset of arrested brittle crack or pop-in.
This term only applies where there <u>is evidence</u> in either a) or b) to suggest that slow crack growth has occurred.

δ_m Crack opening displacement at first attainment of maximum force plateau.

3.0 Summary

This project involved the testing of 147 CTOD specimens prepared from SMAW deposits and 107 CTOD specimens from SAW deposits. All specimens were tx2t (20 x 40 mm) with through-thickness notches. Testing was conducted in accordance with BS5762.

The results of tensile and CTOD testing are included in this report. The tensile properties were supplied by CANMET. The CTOD specimen dimensions, test loads, CTOD values, and fracture type are summarized in Table 2.

After testing had been completed, all 254 CTOD specimens were returned to CANMET for metallurgical examination.

TABLE 1

Weld Metal Yield Strengths

Weld	Yield Strength, MPa
1	521
2	517
3	490
4	574
5	465
6	525
7	507
8	499
9	572
10	576
11	638
12	516
13	494
14	520
15	572
16	486
17	470
18	486
19	553
20	539
SA1	530
SA2	542
SA3	532
SA4	527
SA5	547
SA6	559
SA7	500
SA8	504
SA9	530
SA10	599
SA11	501
SA12	541

TABLE 2

Summary of CTOD Tests

Weld No.	Specimen No.	Test Temperature °C	Specimen Dimensions a mm	B mm	a/W	P kN	V_p mm	CTOD mm	Fracture Type
1	1	-30	18.82	18.69	0.50	28.00	0.053	0.041	c
						30.75	0.401	0.140	u
	2	-30	18.73	18.75	0.49	34.75	0.137	0.079	u
	3	-30	18.66	18.75	0.49	27.75	0.058	0.041	c
						34.25	0.975	0.302	u
	4	-30	18.83	18.72	0.50	32.25	0.104	0.064	c
	5	-30	18.92	18.69	0.50	21.25	0.020	0.020	c
						34.50	0.599	0.201	u
	6	-10	19.13	18.59	0.50	37.87	0.328	0.140	u
	7	-10	18.95	18.62	0.50	36.50	0.229	0.109	u
	8	-10	18.45	18.80	0.49	40.37	0.371	0.155	u
	9	-10	19.62	18.80	0.52	36.37	0.371	0.145	u
2	1	-30	18.71	18.57	0.49	35.13	0.152	0.084	u
	2	-30	18.79	18.59	0.50	31.50	0.097	0.061	c
	3	-30	18.31	18.67	0.48	41.00	0.572	0.213	u
	4	-30	18.86	18.69	0.50	29.00	0.058	0.046	c
	5	-30	18.59	18.59	0.49	35.00	0.142	0.081	u
	6	-10	18.90	18.44	0.50	32.13	0.097	0.064	c
	7	-10	19.19	18.80	0.51	40.50	0.648	0.229	u
	8	-10	18.74	18.54	0.49	43.00	1.621	0.498	m
	9	-10	18.95	18.75	0.50	41.25	1.049	0.338	u

TABLE 2 (Cont'd)

Summary of CTOD Testing

Weld No.	Specimen No.	Test Temperature °C	Specimen Dimensions a mm	B mm	a/W	P kN	V_p mm	CTOD mm	Fracture Type
3	1	-30	19.38	18.77	0.51	29.00	0.104	0.061	c
	2	-30	19.15	18.72	0.51	15.50	0.008	0.010	c
						34.50	0.582	0.198	u
	3	-30	19.12	18.72	0.50	30.50	0.124	0.069	u
	4	-30	19.40	18.72	0.51	33.00	0.249	0.109	u
	5	-30	19.27	18.72	0.51	29.00	0.081	0.056	c
	6	-10	19.35	18.72	0.51	24.12	0.043	0.036	c
						34.75	1.844	0.521	u
	7	-10	19.62	18.72	0.52	37.75	0.478	0.180	u
	8	-10	18.78	18.69	0.49	20.25	0.020	0.020	c
						38.50	0.767	0.259	u
	9	-10	19.21	18.75	0.51	38.50	0.691	0.236	u
4	4	-30	19.24	18.62	0.50	42.13	0.897	0.292	u
	5	-30	19.19	18.59	0.50	41.90	0.620	0.221	u
	6	-10	19.71	18.64	0.52	31.62	0.104	0.064	u
						35.37	0.163	0.452	m
	7	-10	19.17	18.64	0.51	41.00	0.714	0.241	u
	8	-10	20.33	18.67	0.54	35.50	0.505	0.173	u
	9	-10	19.82	18.57	0.52	41.25	1.877	0.528	u
5	4	-30	20.46	18.75	0.54	28.83	0.135	0.074	u
	5	-30	19.19	18.72	0.50	34.10	0.211	0.102	u
	6	-10	19.82	18.67	0.52	34.50	0.495	0.178	u
	7	-10	20.10	18.62	0.53	28.50	0.124	0.071	u
	8	-10	18.96	18.62	0.50	36.62	0.396	0.157	u
	9	-10	19.33	18.67	0.51	22.75	0.028	0.030	c
						30.00	0.371	0.135	u

TABLE 2 (Cont'd)

Summary of CTOD Testing

Weld No.	Specimen No.	Test Temperature °C	Specimen Dimensions a mm	B mm	a/W	P kN	V_p mm	CTOD mm	Fracture Type
6	4	-30	19.88	18.64	0.52	17.00	0.102	0.152	c
						33.63	0.287	0.117	u
	5	-30	19.70	18.64	0.52	35.25	0.257	0.114	u
	6	-10	19.96	18.64	0.53	37.38	1.067	0.320	m
	7	-10	19.17	18.64	0.51	38.38	0.343	0.142	u
	8	-10	19.68	18.69	0.52	39.25	1.638	0.470	m
	9	-10	19.64	18.62	0.52	38.25	0.582	0.203	u
7	4	-30	19.57	18.64	0.51	21.50	0.020	0.023	c
						29.12	0.229	0.091	u
	5	-30	19.27	18.62	0.51	26.50	0.053	0.041	c
	6	-10	20.41	18.64	0.54	21.50	0.038	0.030	c
						30.12	0.706	0.211	u
	7	-10	19.40	18.67	0.51	29.00	0.091	0.056	c
	8	-10	20.09	18.72	0.53	25.75	0.071	0.046	c
	9	-10	19.41	18.59	0.51	25.88	0.058	0.041	c
						32.62	0.876	0.267	u
8	4	-30	18.63	18.64	0.49	34.00	0.173	0.086	u
	5	-30	18.63	18.64	0.49	24.25	0.033	0.030	c
	6	-30	19.30	18.67	0.51	16.62	0.015	0.015	c
						22.00	0.081	0.041	c
	7	-10	19.22	18.69	0.51	28.25	0.071	0.048	c
	8	-10	18.63	18.72	0.49	30.25	0.086	0.056	c
	9	-10	19.07	18.75	0.50	33.25	0.142	0.079	u

TABLE 2 (Cont'd)

Summary of CTOD Testing

Weld No.	Specimen No.	Test Temperature °C	Specimen Dimensions a mm	B mm	a/W	P kN	V_p mm	CTOD mm	Fracture Type
9	4	-30	19.87	18.67	0.52	33.83	0.168	0.084	u
	5	-30	20.24	18.64	0.53	34.25	0.267	0.112	u
	6	-10	19.47	18.64	0.51	40.50	1.229	0.371	u
	7	-10	19.58	18.67	0.52	37.62	0.282	0.122	u
	8	-10	19.60	18.69	0.52	35.75	0.239	0.107	u
	9	-10	19.44	18.67	0.51	39.50	0.886	0.279	m
10	1	-30	18.99	18.62	0.50	33.50	0.099	0.064	c
	2	-30	19.00	18.62	0.50	35.75	0.168	0.086	u
	3	-30	19.36	18.67	0.51	36.50	0.211	0.099	u
	4	-30	19.23	18.67	0.51	37.50	0.305	0.127	u
	5	-30	18.87	18.80	0.50	30.75	0.053	0.043	c
						34.25	0.549	0.183	u
	6	-10	18.75	18.77	0.49	38.63	0.203	0.099	u
						41.50	0.376	0.152	u
	7	-10	19.37	18.67	0.51	39.25	0.419	0.160	u
	8	-10	19.08	18.75	0.50	43.25	1.30	0.399	u
	9	-10	19.29	18.72	0.51	41.25	0.671	0.231	u
11	4	-30	19.78	18.80	0.52	35.63	0.152	0.079	u
						39.50	0.447	0.163	u
	5	-30	19.24	18.67	0.51	35.37	0.137	0.074	c
	6	-10	19.92	18.69	0.52	40.00	0.886	0.272	u
	7	-10	19.59	18.69	0.52	41.25	1.229	0.363	m
	8	-10	20.10	18.64	0.53	39.50	0.886	0.269	m
	9	-10	19.69	18.69	0.52	40.61	0.980	0.300	m

TABLE 2 (Cont'd)
Summary of CTOD Testing

Weld No.	Specimen No.	Test Temperature °C	Specimen Dimensions a mm	B mm	a/W	P kN	V_p mm	CTOD mm	Fracture Type
12	4	-30	19.79	18.64	0.52	17.00	0.010	0.015	c
						27.00	1.011	0.282	u
	5	-30	19.75	18.67	0.52	24.25	0.043	0.036	c
						30.63	0.561	0.178	u
	6	-10	19.41	18.62	0.51	23.75	0.038	0.033	c
						32.00	0.714	0.221	u
	7	-10	19.58	18.69	0.52	36.25	0.249	0.114	u
	8	-10	19.07	18.62	0.50	21.00	0.020	0.023	c
						31.50	0.599	0.193	u
	9	-10	19.28	18.64	0.51	25.00	0.038	0.033	c
						30.25	0.325	0.119	u
13	1	-30	19.54	18.77	0.51	18.87	0.015	0.018	c
						26.75	0.213	0.084	u
	2	-30	18.87	18.72	0.50	24.25	0.010	0.025	c
	3	-30	18.86	18.80	0.50	24.25	0.038	0.030	c
	4	-30	19.49	18.77	0.51	19.63	0.008	0.018	c
						21.50	0.168	0.061	u
	5	-30	18.68	18.69	0.49	26.00	0.038	0.033	c
	6	-10	19.15	18.80	0.50	21.13	0.023	0.023	c
						32.13	0.478	0.163	u
	7	-10	18.60	18.67	0.49	27.62	0.053	0.041	c
	8	-10	19.02	18.77	0.50	27.13	0.058	0.043	c
	9	-10	19.40	18.75	0.51	17.75	0.015	0.018	c
						26.25	0.124	0.058	u
14	4	-30	19.42	18.64	0.51	19.50	0.020	0.020	c
						27.75	0.734	0.218	u
	5	-30	19.40	18.62	0.51	18.75	0.020	0.018	c
						25.25	0.147	0.061	u
	6	-10	19.92	18.75	0.53	15.37	0.015	0.013	c
						25.50	0.467	0.142	u
	7	-10	18.36	18.59	0.51	30.00	0.118	0.061	c
	8	-10	19.88	18.82	0.52	24.00	0.048	0.036	c
						31.88	0.734	0.224	u
	9	-10	19.36	18.75	0.51	24.75	0.038	0.033	c
						30.63	0.424	0.145	u

TABLE 2 (Cont'd)
Summary of CTOD Testing

Weld No.	Specimen No.	Test Temperature °C	Specimen Dimensions a mm	B mm	a/W	P kN	V_p mm	CTOD mm	Fracture Type
15	1	-30	18.89	18.62	0.50	43.75	0.919	0.305	u
	2	-30	19.10	18.80	0.50	41.37	0.709	0.241	u
	3	-30	18.91	18.75	0.50	28.38	0.038	0.036	c
						36.37	0.447	0.160	u
	4	-30	18.91	18.80	0.50	42.25	0.653	0.229	u
	5	-30	19.41	18.80	0.51	37.00	0.249	0.112	u
	6	-10	19.13	18.80	0.50	43.25	1.105	0.351	m
	7	-10	19.31	18.62	0.51	41.88	1.128	0.351	m
	8	-10	18.95	18.75	0.50	39.25	0.272	0.122	u
	9	-10	19.26	18.69	0.51	42.00	1.491	0.446	m
16	1	-30	19.01	18.75	0.50	14.12	0.005	0.010	c
						24.63	0.119	0.055	u
	2	-30	18.72	18.67	0.49	34.25	0.206	0.099	u
	3	-30	19.20	18.62	0.51	16.75	0.010	0.013	c
						20.75	0.168	0.061	u
	4	-30	19.24	18.67	0.51	26.25	0.061	0.043	c
	5	-30	19.35	18.67	0.51	28.87	0.091	0.058	c
	6	-10	19.04	18.72	0.50	30.12	0.076	0.056	c
	7	-10	18.92	18.62	0.50	20.00	0.020	0.020	c
						28.13	0.229	0.091	u
	8	-10	19.44	18.67	0.51	30.00	0.104	0.064	c
	9	-10	18.99	18.69	0.50	22.00	0.020	0.023	c
						24.38	0.457	0.142	u

TABLE 2 (Cont'd)

Summary of CTOD Testing

Weld No.	Specimen No.	Test Temperature °C	Specimen Dimensions a mm	B mm	a/W	P kN	V_p mm	CTOD mm	Fracture Type
17	1	-30	19.75	18.75	0.52	24.00	0.036	0.036	c
						30.00	1.781	0.483	u
	2	-30	19.35	18.67	0.51	33.25	0.201	0.100	u
	3	-30	19.15	18.64	0.50	41.00	0.277	0.140	u
	4	-30	19.13	18.64	0.50	15.50	0.010	0.013	c
						32.62	0.401	0.147	u
	5	-30	19.23	18.64	0.51	19.25	0.010	0.018	c
						28.38	0.218	0.089	u
	6	-10	19.02	18.64	0.50	36.50	0.277	0.127	u
	7	-10	18.92	18.72	0.50	38.25	0.401	0.163	u
	8	-10	19.25	18.67	0.51	23.00	0.038	0.033	c
						37.13	2.106	0.600	m
	9	-10	19.04	18.75	0.50	40.63	1.552	0.472	u
18	4	-30	21.09	18.75	0.56	31.75	0.820	0.239	u
	5	-30	19.28	18.75	0.51	30.75	0.137	0.074	u
	6	-10	20.31	18.69	0.54	35.00	0.859	0.264	u
	7	-10	19.66	18.75	0.52	34.75	0.371	0.145	u
	8	-10	18.94	18.72	0.50	38.75	0.973	0.312	u
	9	-10	19.16	18.75	0.50	37.25	0.457	0.173	u

TABLE 2 (Cont'd)
Summary of CTOD Testing

Weld No.	Specimen No.	Test Temperature °C	Specimen Dimensions a mm	B mm	a/W	P kN	V_p mm	CTOD mm	Fracture Type
19	1	-30	19.18	18.64	0.50	39.25	0.500	0.183	u
	2	-30	19.03	18.59	0.50	36.50	0.244	0.109	u
	3	-30	19.14	18.69	0.50	40.63	0.648	0.226	u
	4	-30	18.86	18.67	0.50	38.50	0.305	0.130	u
	5	-30	19.35	18.69	0.51	27.62	0.058	0.043	c
						29.25	1.110	0.315	u
	6	-10	18.93	18.59	0.50	42.24	1.552	0.470	m
	7	-10	18.58	18.69	0.49	41.75	0.442	0.175	u
	8	-10	18.76	18.69	0.49	43.25	1.247	0.394	m
	9	-10	19.85	18.67	0.52	35.00	0.305	0.122	u
20	4	-30	27.14	18.72	0.71	12.13	0.249	0.058	u
	5	-30	22.03	18.54	0.58	26.75	0.630	0.175	u
	6	-10	23.01	18.26	0.61	24.63	0.866	0.211	u
	7	-10	17.71	18.39	0.47	43.63	1.400	0.457	u
	8	-10	18.90	18.59	0.50	38.00	0.333	0.137	u
	9	-10	19.36	18.47	0.51	38.13	0.790	0.257	u

TABLE 2 (Cont'd)

Summary of CTOD Testing

Weld No.	Specimen No.	Test Temperature °C	Specimen Dimensions a mm	B mm	a/W	P kN	V_p mm	CTOD mm	Fracture Type
SA1	1	-30	19.47	17.81	0.51	32.75	0.320	0.127	u
	2	-30	19.25	17.81	0.51	34.38	0.333	0.135	u
	3	-30	18.86	17.81	0.50	36.88	0.582	0.206	u
	4	-30	19.49	17.73	0.51	34.88	0.605	0.206	u
	5	-30	20.47	17.73	0.54	32.75	0.973	0.282	u
	6	-10	20.08	17.81	0.53	32.50	0.414	0.150	u
	7	-10	19.86	17.83	0.52	36.37	1.791	0.500	m
	8	-10	18.81	17.83	0.50	37.75	0.686	0.236	u
	9	-10	19.15	17.83	0.50	37.75	1.029	0.325	u
SA2	1	-30	18.93	17.78	0.50	32.25	0.163	0.081	u
	2	-30	19.72	17.81	0.52	34.00	0.724	0.231	u
	3	-30	20.80	17.81	0.55	32.00	2.210	0.559	m
	4	-30	19.93	17.81	0.53	34.38	2.210	0.592	m
	5	-30	19.18	17.81	0.51	38.38	2.047	0.587	m
	6	-10	18.67	17.81	0.49	39. 2	1.800	0.536	m
	7	-10	20.13	17.73	0.53	34.88	2.220	0.594	m
	8	-10	18.90	17.81	0.50	39.63	2.220	0.645	m
	9	-10	18.90	17.81	0.50	38.50	1.595	0.478	m
SA3	1	-30	19.17	17.83	0.51	38.87	2.258	0.643	u
	2	-30	19.59	17.83	0.52	35.25	0.653	0.218	u
	3	-30	19.90	17.81	0.53	36.25	2.210	0.600	m
	4	-30	19.16	17.81	0.51	39.00	2.200	0.630	m
	5	-30	18.85	17.81	0.50	39.75	1.933	0.572	m
	6	-10	19.18	17.83	0.51	40.25	2.210	0.635	m
	7	-10	20.34	17.81	0.54	35.25	2.144	0.569	m
	8	-10	19.59	17.83	0.52	38.00	2.210	0.617	m
	9	-10	19.28	17.81	0.51	39.50	2.210	0.633	m

TABLE 2 (Cont'd)
Summary of CTOD Testing

Weld No.	Specimen No.	Test Temperature °C	Specimen Dimensions a mm	B mm	a/W	P kN	V_p mm	CTOD mm	Fracture Type
SA4	1	-30	19.03	17.73	0.50	32.20	0.180	0.089	u
	2	-30	19.68	17.78	0.52	34.00	0.676	0.218	u
	3	-30	19.35	17.73	0.51	35.37	0.790	0.254	u
	4	-30	20.54	17.73	0.54	30.63	0.452	0.155	u
	5	-30	19.58	17.73	0.52	33.25	0.495	0.173	u
	6	-10	19.17	17.73	0.50	33.75	0.290	0.122	u
	7	-10	19.98	17.73	0.53	34.63	1.887	0.516	m
	8	-10	19.13	17.73	0.50	38.75	1.981	0.577	u
	9	-10	19.22	17.73	0.51	37.38	1.191	0.366	u
SA5	1	-30	19.17	17.78	0.50	35.12	0.330	0.135	u
	2	-30	19.94	17.78	0.53	32.25	0.330	0.127	u
	3	-30	19.34	17.81	0.51	37.00	0.889	0.282	u
	4	-30	19.00	17.75	0.50	30.50	0.127	0.069	u
	5	-30	19.20	17.78	0.51	37.13	0.813	0.264	u
	6	-10	18.89	17.75	0.50	39.25	1.803	0.531	u
	7	-10	19.21	17.73	0.51	37.00	0.635	0.218	u
	8	-10	18.58	17.70	0.49	40.25	1.778	0.539	u
	9	-10	19.20	17.81	0.51	37.00	0.533	0.191	u
SA6	1	-30	19.27	17.81	0.51	38.50	1.700	0.495	m
	2	-30	19.70	17.78	0.52	33.50	0.406	0.147	u
						36.25	1.382	0.400	m
	3	-30	18.75	17.78	0.49	38.38	0.925	0.300	u
	4	-30	19.83	17.78	0.52	35.00	1.209	0.351	u
	5	-30	19.52	17.81	0.51	34.00	0.366	0.140	u
						36.88	1.648	0.472	m
	6	-10	18.56	17.78	0.49	40.88	1.930	0.580	m
	7	-10	19.12	17.78	0.50	39.25	2.209	0.633	m
	8	-10	19.80	17.78	0.52	33.00	0.330	0.127	u
	9	-10	19.81	17.81	0.52	36.25	2.210	0.602	m

TABLE 2 (Cont'd)

Summary of CTOD Testing

Weld No.	Specimen No.	Test Temperature °C	Specimen Dimensions a mm	B mm	a/W	P kN	V_p mm	CTOD mm	Fracture Type
SA7	1	-30	19.48	17.73	0.51	35.12	0.660	0.224	u
	2	-30	19.27	17.73	0.51	33.50	0.356	0.140	u
	3	-30	19.52	17.70	0.51	35.12	0.838	0.269	u
	4	-30	19.63	17.73	0.52	33.87	0.660	0.218	u
	5	-30	19.50	17.73	0.51	33.63	0.483	0.173	u
	6	-10	19.78	17.70	0.52	32.87	0.356	0.140	u
	7	-10	19.68	17.70	0.52	37.38	1.905	0.541	m
	8	-10	19.70	17.73	0.52	37.00	2.210	0.615	m
	9	-10	19.18	17.73	0.51	37.00	0.914	0.295	u
SA8	1	-30	19.67	17.65	0.52	19.00	0.025	0.023	c
	2	-30	19.25	17.65	0.51	30.00	0.152	0.079	u
	3	-30	20.38	17.65	0.54	27.13	0.178	0.081	u
	4	-30	19.31	17.63	0.51	33.50	0.381	0.147	u
	5	-30	20.47	17.70	0.54	20.37	0.051	0.033	u
	6	-10	20.14	17.63	0.53	31.13	0.356	0.135	u
	7	-10	20.71	17.63	0.55	28.75	0.279	0.112	u
	8	-10	19.12	17.65	0.50	35.00	0.432	0.165	u
	9	-10	19.34	17.65	0.51	35.00	0.533	0.191	u
SA9	1	-30	19.93	17.70	0.53	30.25	0.305	0.117	u
	2	-30	19.53	17.70	0.51	30.63	0.229	0.099	u
	3	-30	20.33	17.70	0.53	27.87	0.203	0.086	u
	4	-30	19.52	17.70	0.51	31.00	0.254	0.104	u
	5	-30	19.95	17.70	0.53	31.37	0.483	0.163	u
	6	-10	20.51	17.70	0.54	28.50	0.254	0.102	u
	7	-10	19.09	17.70	0.50	35.63	0.838	0.269	u
	8	-10	19.67	17.68	0.52	33.75	0.813	0.254	u
	9	-10	20.78	17.68	0.55	29.88	0.737	0.218	u

TABLE 2 (Cont'd)

Summary of CTOD Testing

Weld No.	Specimen No.	Test Temperature °C	Specimen Dimensions a mm	B mm	a/W	P kN	V_p mm	CTOD mm	Fracture Type
SA10	1	-30	19.21	18.75	0.51	35.75	0.178	0.086	u
	2	-30	19.45	18.75	0.51	39.25	0.508	0.180	u
	3	-30	19.38	18.72	0.51	39.38	0.686	0.226	u
	4	-30	18.69	18.75	0.49	39.88	0.279	0.122	u
	5	-30	18.96	18.75	0.50	38.25	0.229	0.107	u
	6	-10	19.66	18.72	0.52	37.38	0.635	0.208	m
	7	-10	19.21	18.72	0.51	39.12	0.508	0.180	m
	8	-10	19.17	18.75	0.51	39.63	0.381	0.150	u
	9	-10	19.48	18.75	0.51	38.25	0.508	0.178	m
SA11	1	-30	19.48	18.72	0.51	37.75	0.838	0.269	u
	2	-30	19.95	18.72	0.53	33.50	0.305	0.124	u
	3	-30	21.04	18.69	0.55	31.13	0.559	0.178	u
	4	-30	19.26	18.80	0.51	37.87	0.711	0.239	u
	5	-30	18.52	18.69	0.49	35.00	0.152	0.084	u
	6	-10	19.72	18.72	0.52	38.63	2.159	0.599	m
	7	-10	19.03	18.72	0.50	40.50	1.371	0.419	u
	8	-10	18.98	18.72	0.50	34.00	0.152	0.084	u
SA12	1	-30	20.11	18.72	0.53	38.25	1.651	0.460	u
	2	-30	19.41	18.69	0.51	41.75	1.854	0.538	u
	3	-30	19.25	18.72	0.51	42.87	2.210	0.635	m
	4	-30	19.70	18.75	0.52	40.12	2.108	0.589	m
	5	-30	19.03	18.69	0.50	40.25	0.660	0.229	u
	6	-10	19.00	18.69	0.50	43.50	2.210	0.645	m
	7	-10	19.20	18.69	0.51	40.12	0.508	0.188	u
						42.13	2.210	0.635	m
	8	-10	19.03	18.72	0.50	41.50	0.838	0.279	u
	9	-10	19.09	18.67	0.50	43.00	2.210	0.640	m

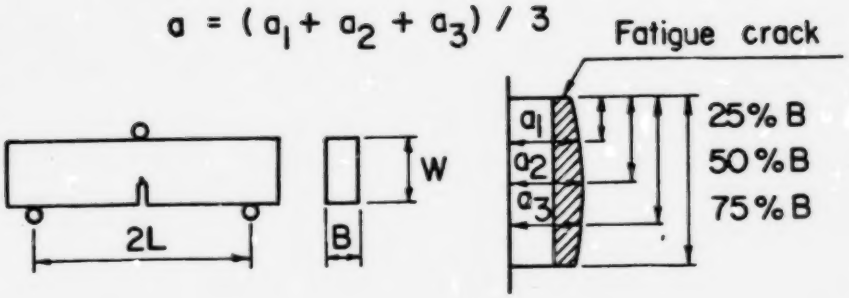


Figure 1. Positions for measurement of fatigue crack lengths.

APPENDIX A

LOAD/CLIP GAUGE DISPLACEMENT CURVES

X-AXIS 10V = 2·5mm ; CHART 0·5V = 1CM ≡ 0·00375"
Y-AXIS 10V = 100KN ; CHART 0·25V = 1CM = 2·5 KN OR 562 LBS

Tested by Ian Montgomery.
24th Feb 86 Specs. 1
25th Feb Specs 10

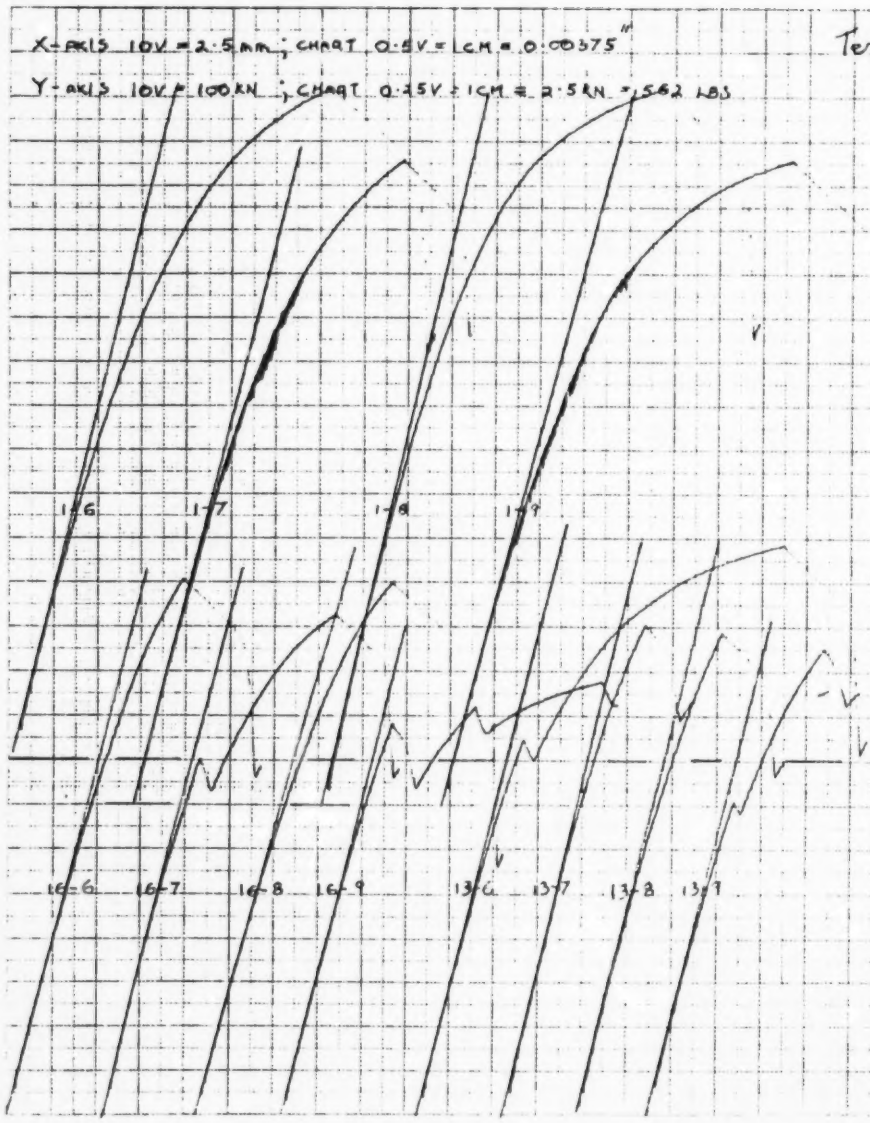
Contract # RC-295/1

Tx 2T Specimens
Tx & Temp 30°C

$\frac{a}{W}$ = 0·5
Span 6·000

Spec	X	Y	
1-1	0·55	11·2	[redacted] ·C
	4·2	12·3	SM
1-2	1·45	13·7	SM
1-3	0·6	11·1	[redacted] SC
	10·25	13·7	SM
1-4	1·1	12·9	[redacted] SC
1-5	0·2	8·5	SC
	6·3	~~13·5~~ 14·4	SM
10-1	1·05	13·4	[redacted] SC
10-2	1·75	14·3	SM
10-3	3·2	14·6	SM
10-4	3·2	15·0	SM
10-5	0·45	12·3	SC
	5·75	14·7	SM
		13·7	

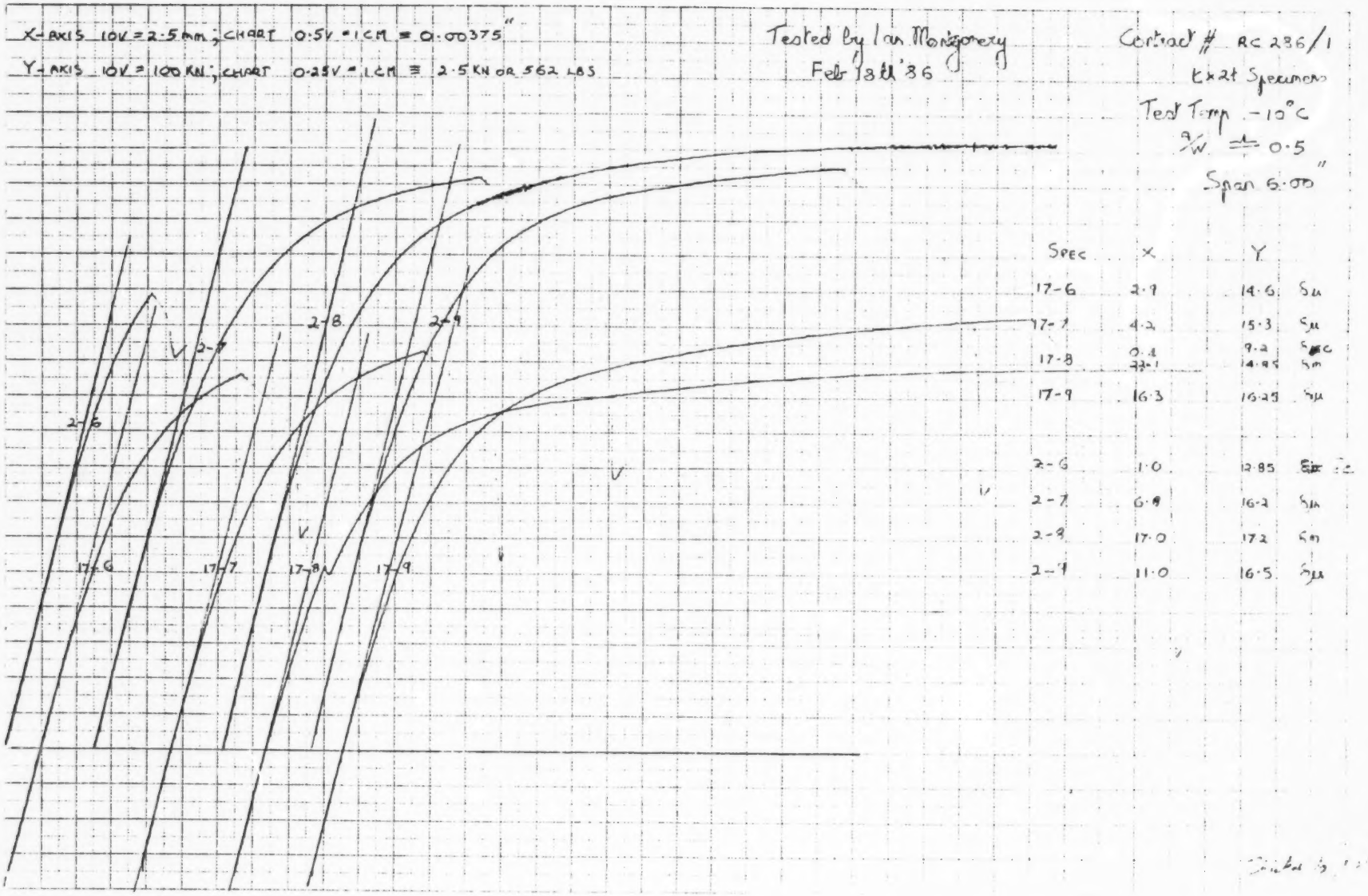
Marked by [illegible]



Tested by Ian Montgomery
Feb 20th '86 16 Series
24th '86 13,1 Series

Contract # RC-236/1
T×2T SPECS
Test Temp -10°C
$\frac{a}{W} = 0.5$
Span 6·00"

SPEC	X	Y	
16-6	0·9	12·05	[illegible]
	0·2	8·0	[illegible]
16-7	2·4	11·25	[illegible]
16-8	1·1	12·0	[illegible]
16-9	0·2	9·9	[illegible]
	2·1	9·2	[illegible]
	4·8	9·75	[illegible]
13-6	0·25	9·45	[illegible]
	5·00	12·95	[illegible]
13-7	0·35	11·05	[illegible]
13-8	0·6	10·85	[illegible]
13-9	0·15	7·1	[illegible]
	1·3	10·5	[illegible]
1-6	3·45	15·15	[illegible]
1-7	2·4	14·6	[illegible]
1-8	3·7	16·15	[illegible]
1-9	3·9	14·5	[illegible]

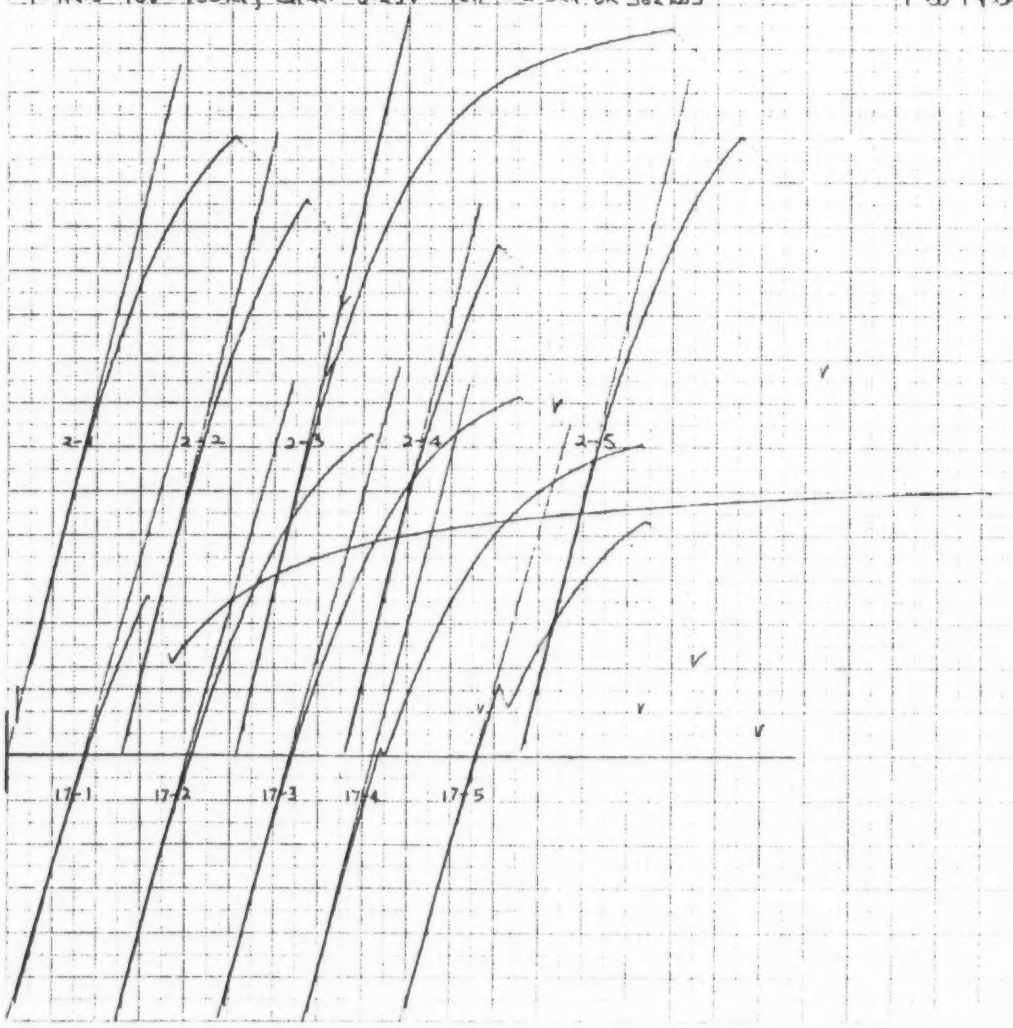

X-AXIS 10V = 2·5 mm; CHART 0·5V = 1CM = 0·00375"
Y-AXIS 10V = 100 KN; CHART 0·25V = 1CM ≡ 2·5 KN OR 562 LBS
Tested by Ian Montgomery
Feb 18th '36
Contract # RC 236/1
4 x 2t Specimens
Test Temp -10°C
g/w ± 0·5
Span 6·00"
Spec X Y
17-6 2·9 14·6 Sμ
17-7 4·2 15·3 Sμ
17-8 0·8 9·2 Spec
23·1 14·95 Sm
17-9 16·3 16·25 Sμ
2-6 1·0 12·85 Sμ
2-7 6·9 16·2 Sμ
2-9 17·0 17·2 Sm
2-8 11·0 16·5 Sμ
2-6
2-7
2-8
2-9
17-6
17-7
17-8
17-9

X-AXIS 10V = 2·5mm; CHART 0·5V = 1CM = 0·00375"

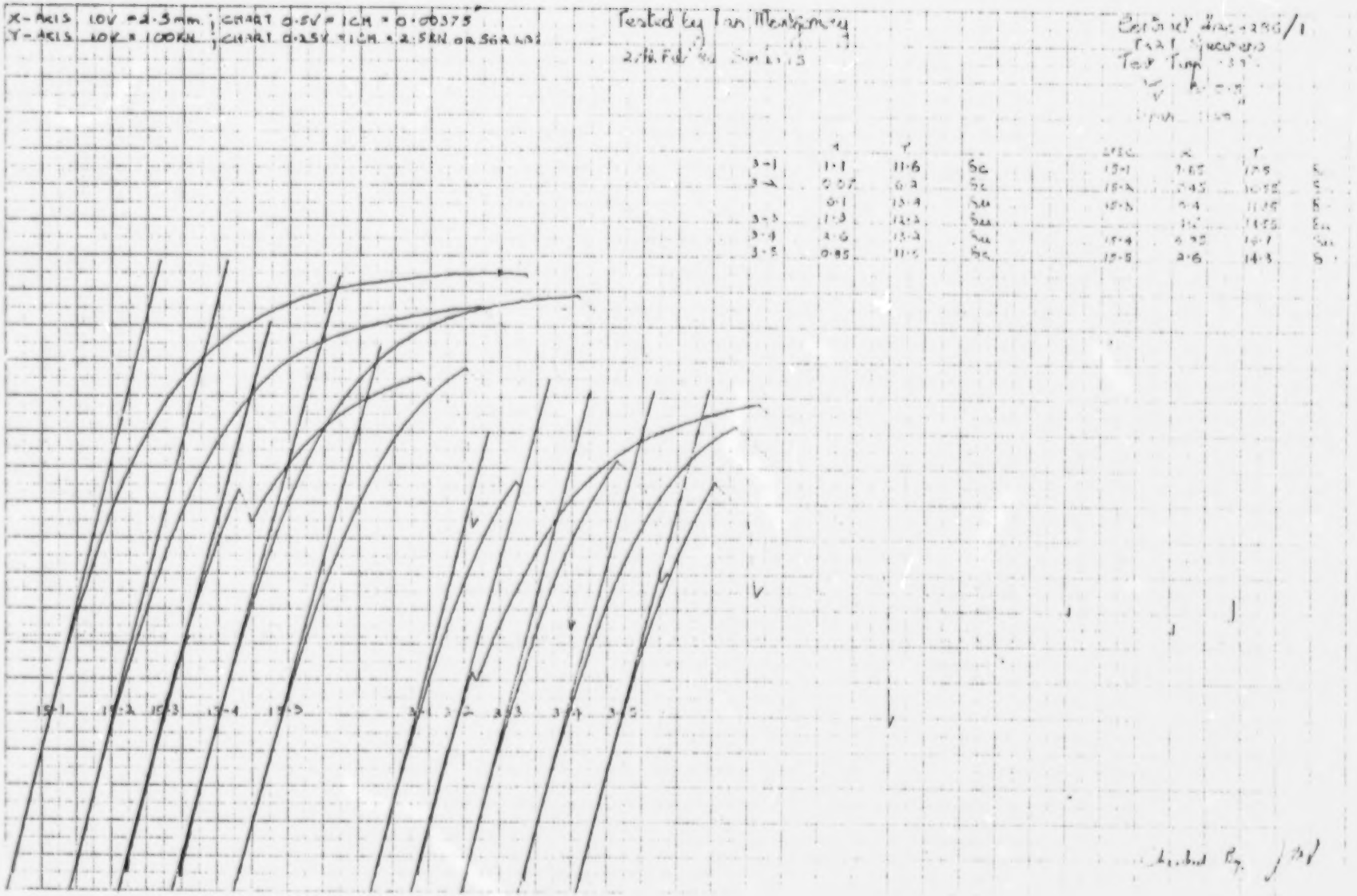
Y-AXIS 10V = 100KN; CHART 0·25V = 1CM = 2·5KN. OR 562 LBS

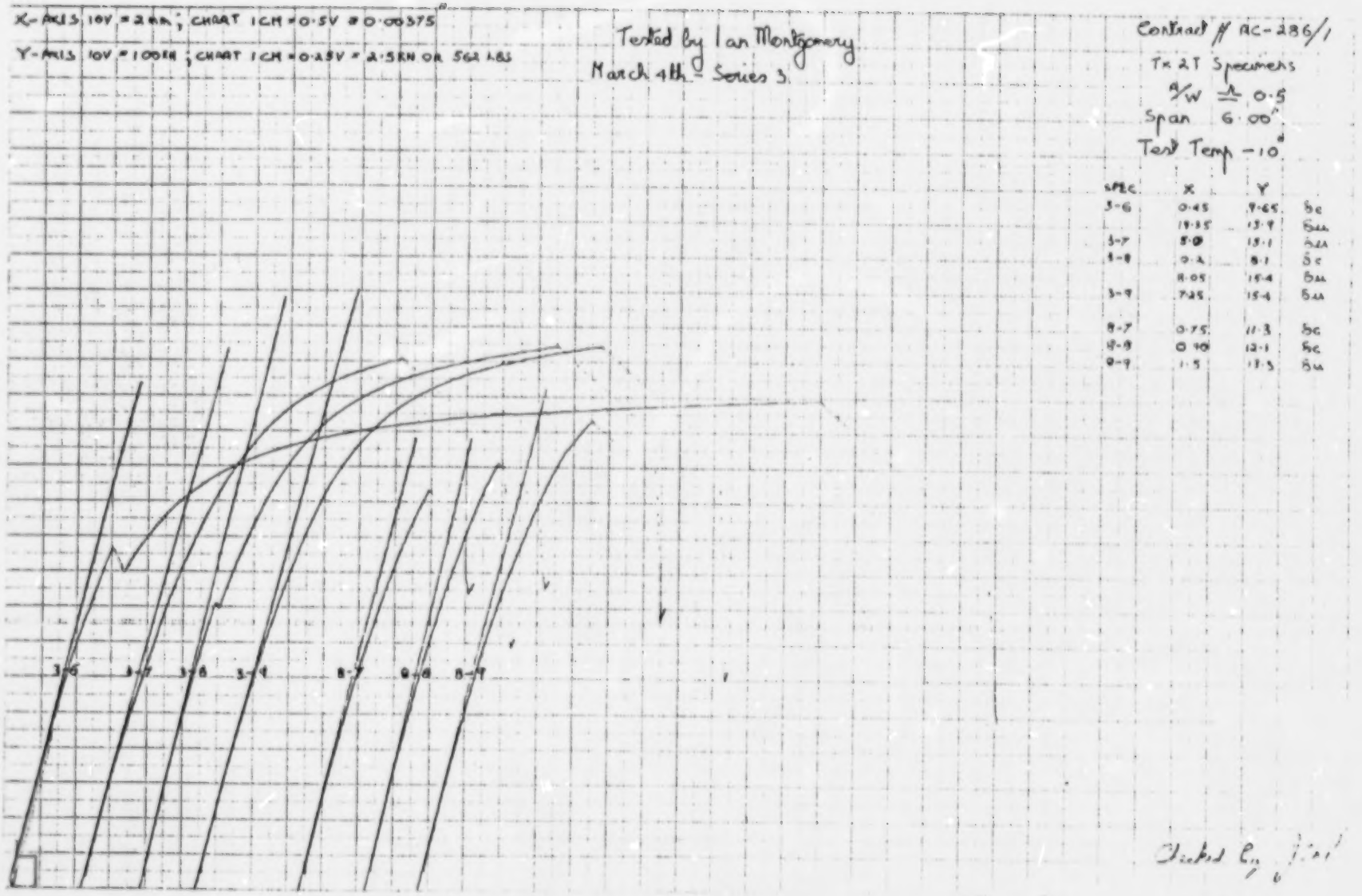
Tested By Ian Montgomery
Feb 14th '86

Contract # AC 296/1
C-2L Specs
Test Temp -30°C
$\frac{9}{16}$" ⊥ 0·5
Span 6·00"



SPEC	X	Y	Sc
	0·4	9·5	Su
17-1	19·7	4·0	
17-2	2·1	13·3	Su
17-3	2·9	14·1	Su
	0·1	6·2	Sc
17-4	4·2	13·05	Su
	0·1	7·7	Sc
17-5	2·3	11·35	Su
2-1	1·6	14·05	Su
2-2	1·0	12·6	Sc
2-3	6·0	16·4	Su
2-4	0·6	11·6	Sc
2-5	1·5	14·0	Su


X-AXIS 10V = 2·5mm ; CHART 0·5V = 1CM = 0·00375
Y-AXIS 10K = 100KN ; CHART 0·25K = 1CM = 2·5KN OR 5KN
Tested by Tun Mentzsmeyer
15-1
15-2
15-3
15-4
15-5
3-1
3-2
3-3
3-4
3-5


X-AXIS 10V = 2 KN ; CHART 1 CM = 0·5V = 0·05 KN
Y-AXIS 10V = 1000 LB ; CHART 1 CM = 0·25V = 2·5 KN OR 562 LBS
Tested by Ian Montgomery
March 4th - Series 3.
Contract # AC-286/1
Tx 2T Specimens
a/w ≐ 0·5
Span 6·00"
Test Temp -10°
Spec X Y
3-6 0·45 9·65 Sc
19·35 13·9 Sm
3-7 5·0 13·1 Sm
3-8 0·2 8·1 Sc
8·05 15·4 Sm
3-9 7·25 15·4 Sm
8-7 0·75 11·3 Sc
8-8 0·10 12·1 Sc
8-9 1·5 13·5 Sm
3-6
3-7
3-8
3-9
8-7
8-8
8-9

RC 23.

Y- AXIS 10V = 100kN .25V/cm 1 cm = 562 lbs

X- AXIS 10V = 1.904 mm .5V/cm 1 cm = 0.375"

Tested By [illegible]

Date Dec 12/85

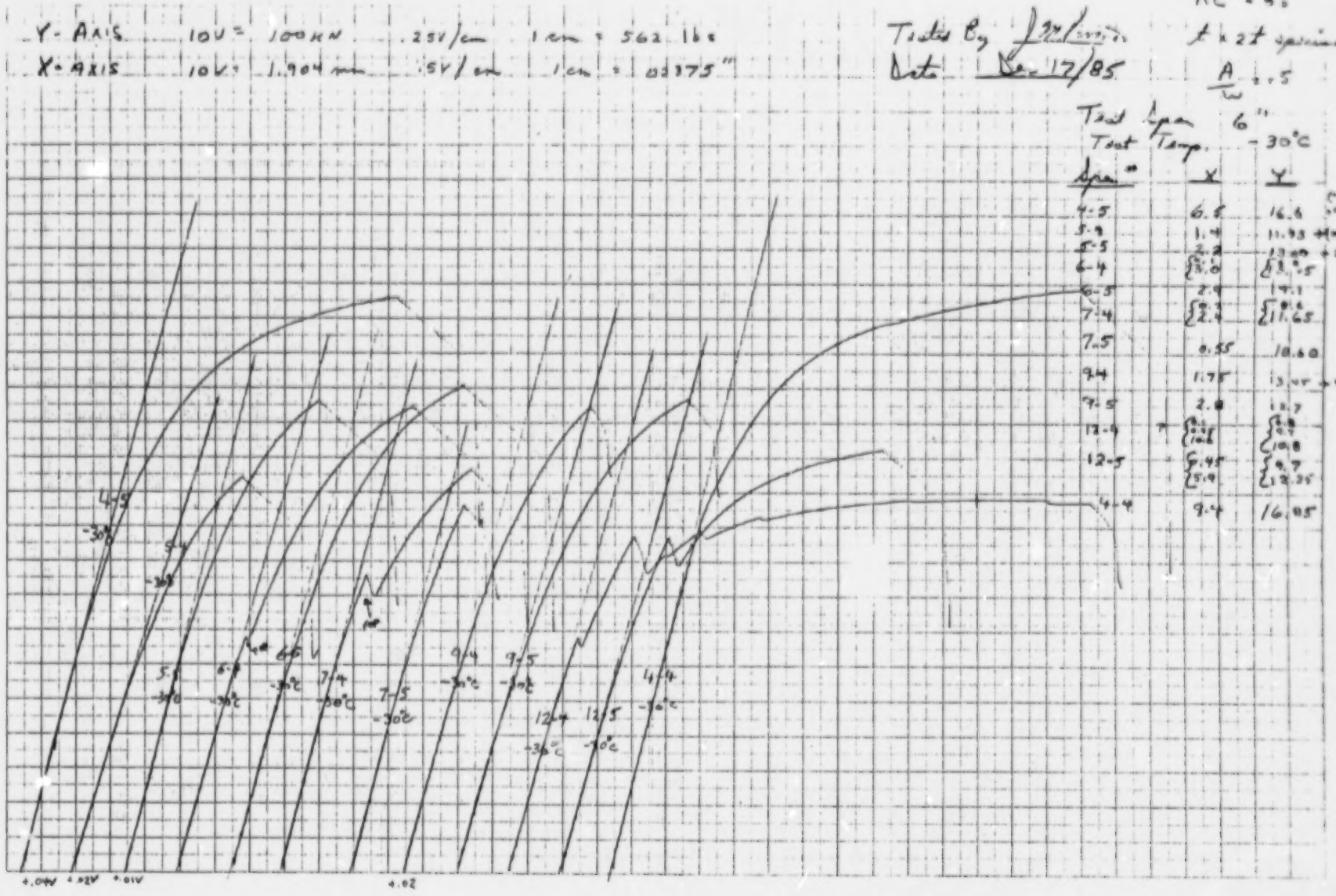
t x 2t specimen

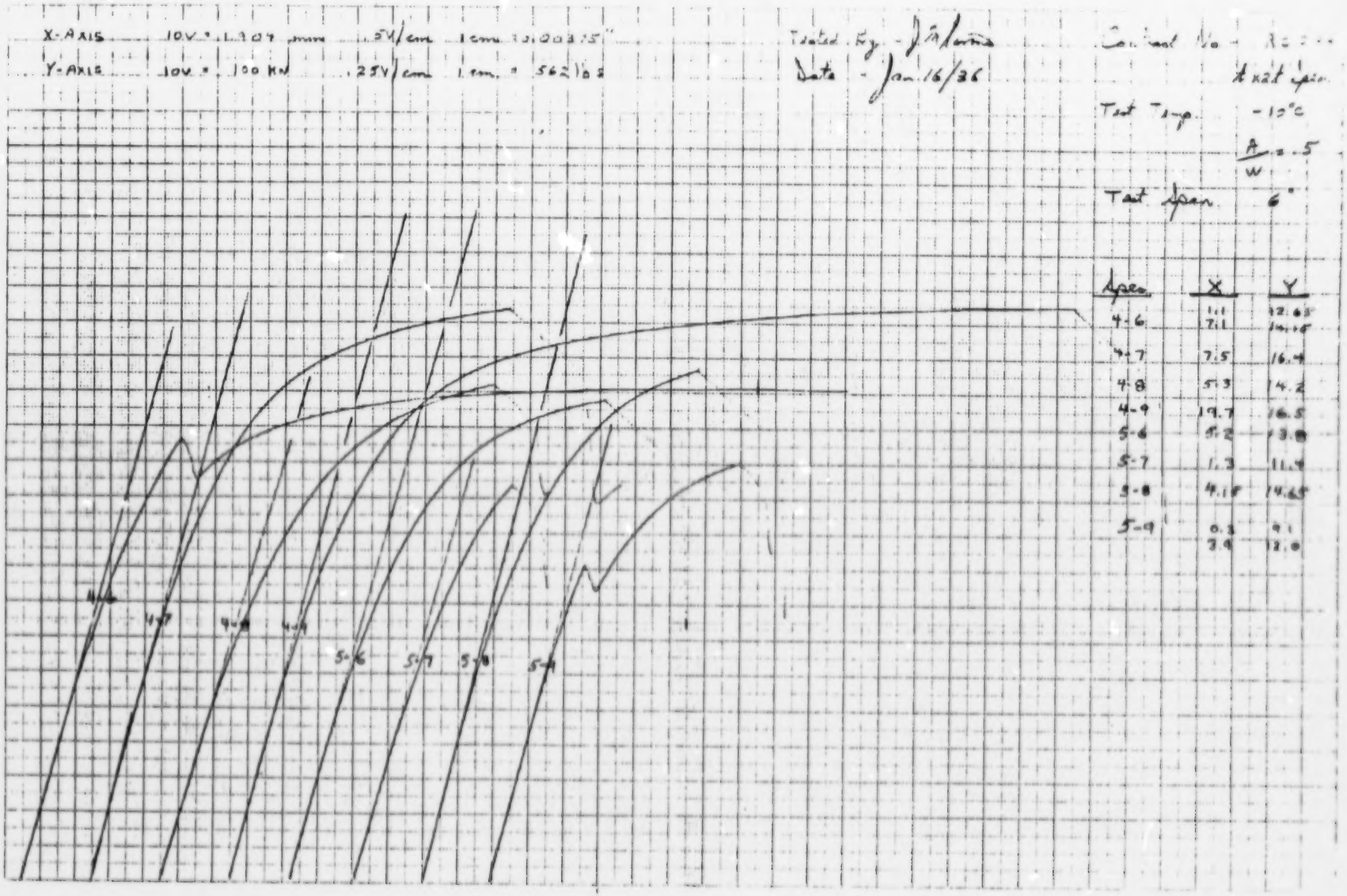
A / tw = 0.5

Test Span 6"

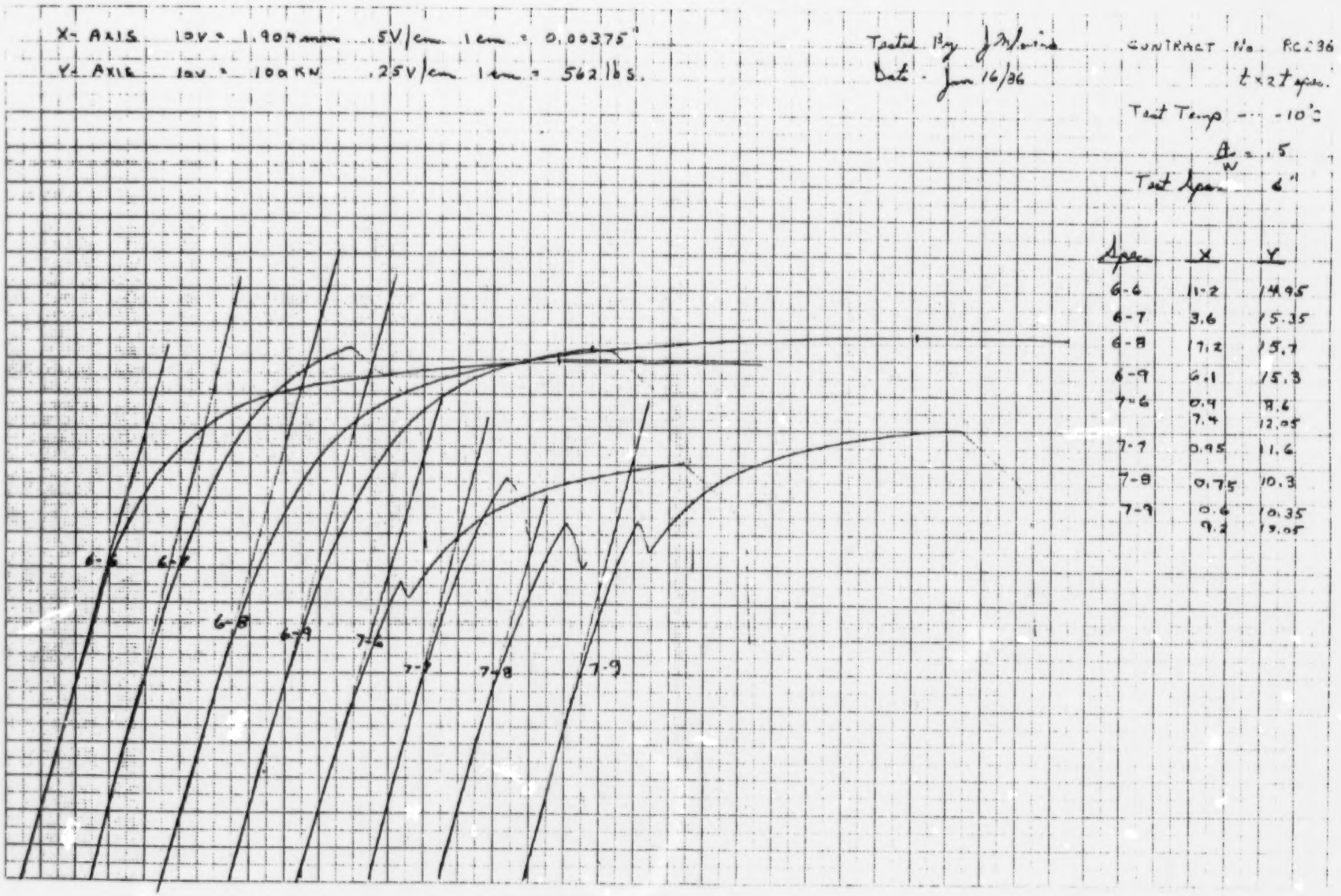
Test Temp. -30°C

Span"	X	Y
4-5	6.6	16.6 (max)
5-4	1.4	11.93 (max)
5-5	2.2	13.00 + 2 lbs
6-4	3.0	13.25
6-5	2.9	14.1
7-4	2.3	11.65
7-5	0.55	10.60
9-4	1.75	13.00 + 0.65
9-5	2.8	12.7
12-4	1.25	10.8
12-5	6.45	9.7
	5.9	12.35
4-4	9.4	16.05





Spec	X	Y
4-6	1:1	12.65
	7:1	14.15
4-7	7.5	16.4
4-8	5.3	14.2
4-9	19.7	16.5
5-6	5.2	13.8
5-7	1.3	11.4
5-8	4.15	14.65
5-9	0.3	9.1
	3.9	12.0



Span	X	Y
6-6	11.2	14.95
6-7	3.6	15.35
6-8	17.2	15.7
6-9	6.1	15.3
7-6	0.9	8.6
	7.4	12.05
7-7	0.95	11.6
7-8	0.75	10.3
7-9	0.6	10.35
	9.2	13.05

X-Axis 10V = 2·5mm; CHART 0·5V = 1CM ≡ 0·00375"
Y-Axis 10V = 100KN; CHART 0·25V = 1CM = 2·5 KN OR 562 LBS

Tested by Ian Montgomery
(25th Feb' BS Series 19

Contract # A.C. - 236/1.
T.S.2.5 Specimens
Test Temp +30°C.
a/w = h = 0·5"
Span 6·00"

SPEC.	X	Y	
17-1	5·25	15·7	Su
17-2	2·55	14·6	Su
17-3	6·9	16·25	Su
17-4	7·2	15·4	"
17-5	0·6	11·85	Sc
	11·65	11·7	Su
8-4	1·8	13·6	Su
8-5	0·35	9·7	Sc
8-6	0·15	6·65	Sc
	0·85	8·8	Sc

17-1 17-2 17-3 17-4 17-5 8-4 8-5 8-6

X-AXIS 10V = 1.904 mm .5V/cm 1 cm = 0.00375"

Y-AXIS 10V = 100KN .25V/cm 1 cm = 562 lbs

Tested By - J. R. Irvine

Date - Jan 16/86

Contract No. PC 230

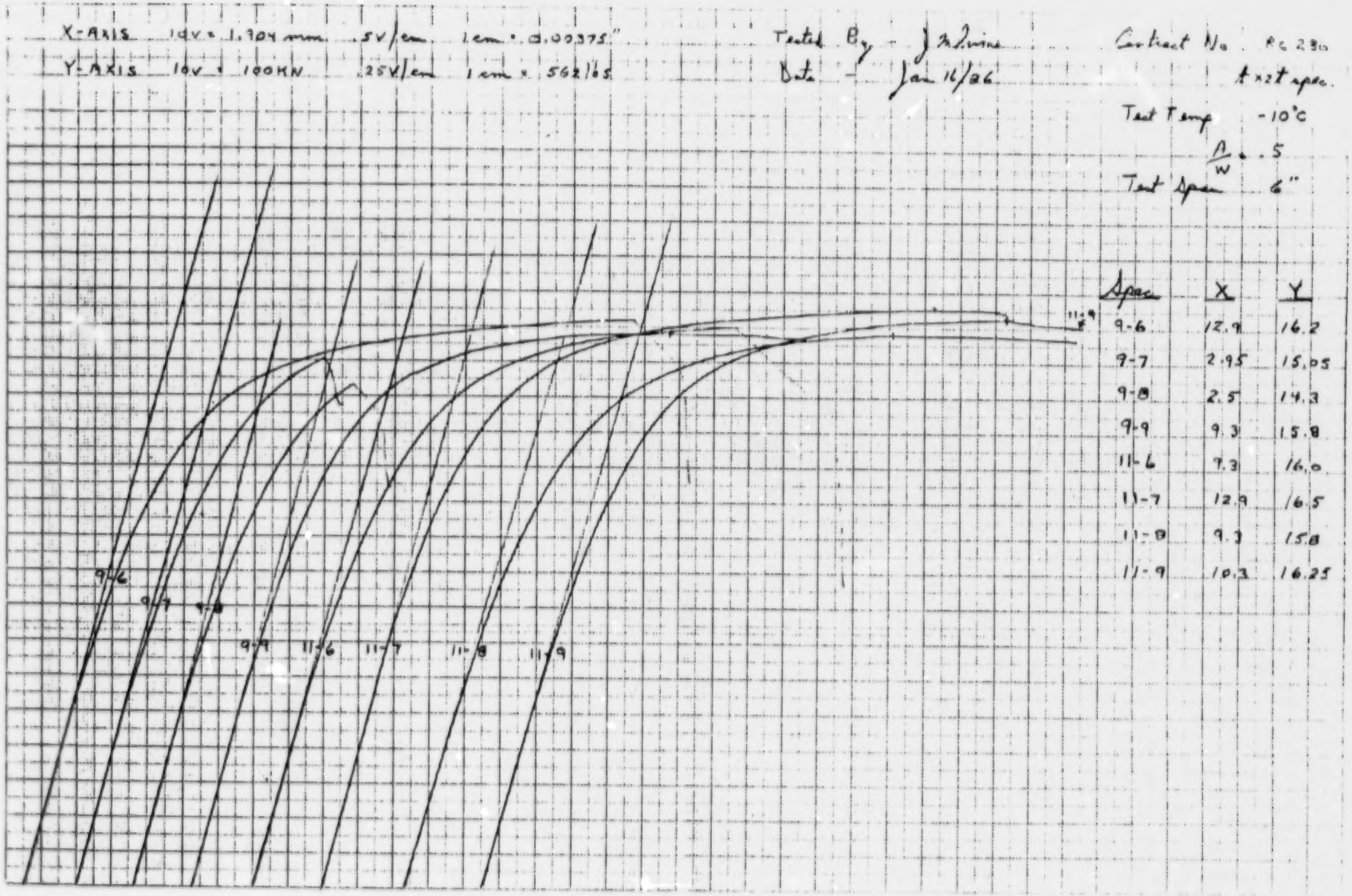
4 x 2 tape

Test Temp -10°C

$\frac{A}{W}$ = .5

Test Span 6"

Span	X	Y
9-6	12.9	16.2
9-7	2.95	15.05
9-8	2.5	14.3
9-9	9.3	15.8
11-6	7.3	16.0
11-7	12.9	16.5
11-8	9.3	15.8
11-9	10.3	16.25



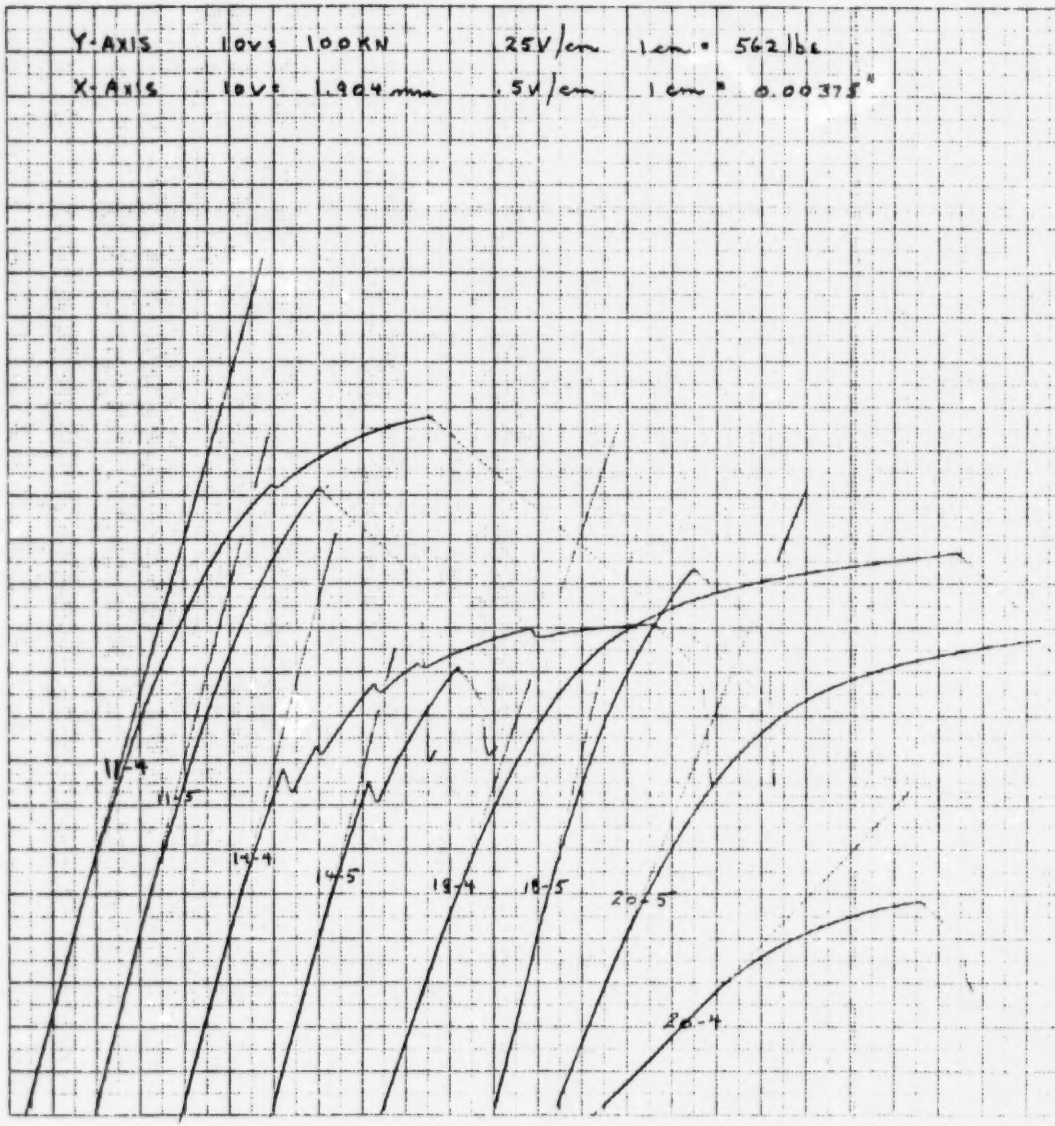
X-Axis 10V = 2·5mm ; CHART 0·5V = C.M. = 0·00375"
Y-Axis 10V = 100 kN ; CHART 0·25V = 1CM = 2·5 kN OR 562 LBS

Tested by Ian Montgomery
26th Feb' 86 Series 10
27th " " Series 15

Contract # AC-286/1
TK 2.T. Specimens
Test Temp — 10°C
A/W = 0·5
Span 6·00"

SPEC	δ_{0}	δ_{95}	δ_{av}
10-6	5·95	16·6	Su
10-7	4·4	15·7	Su
10-8	13·6	17·3	Su
10-9	7·05	16·5	Su
15-6	11·6	17·3	Sm
15-7	11·95	16·75	Sm
15-8	3·85	15·7	Su
15-1	15·7	16·9	Sm

10-6 10-7 10-8 10-9 15-6 15-7 15-8 15-9



Y-AXIS 10V = 100 KN 25V/cm 1 cm = 562 lbs

X-AXIS 10V = 1.904 mm .5V/cm 1 cm = 0.00375"

Tested By - J. M. Lemire

Date - Jan 15/86

Contract No. RC 286

1" x 2" specimen

Test Temp. -30°C

$\frac{A}{W} = .5$

Test Span 6"

Spec	X	Y	
	1.6	14.25	Sw
11-4	4.7	15.3	Sw
11-5	1.45	14.5	Sc
	0.2	7.8	Sc
14-4	7.7	11.1	Sw
14-5	0.2	1.5	Sc
	1.55	10.1	Sw
18-4	3.6	12.7	Sw
18-5	1.45	12.3	Sw
20-4	2.6	4.95	Sw
20-5	6.6	10.7	Sw

X-AXIS 10V = 1.904 mm 5V/cm 1 cm = 0.00375"

Y-AXIS 10V = 1.001 kN 25V/cm 1 cm = 562 lbs

Tested By - J Mivara

Date - Jan 17/86

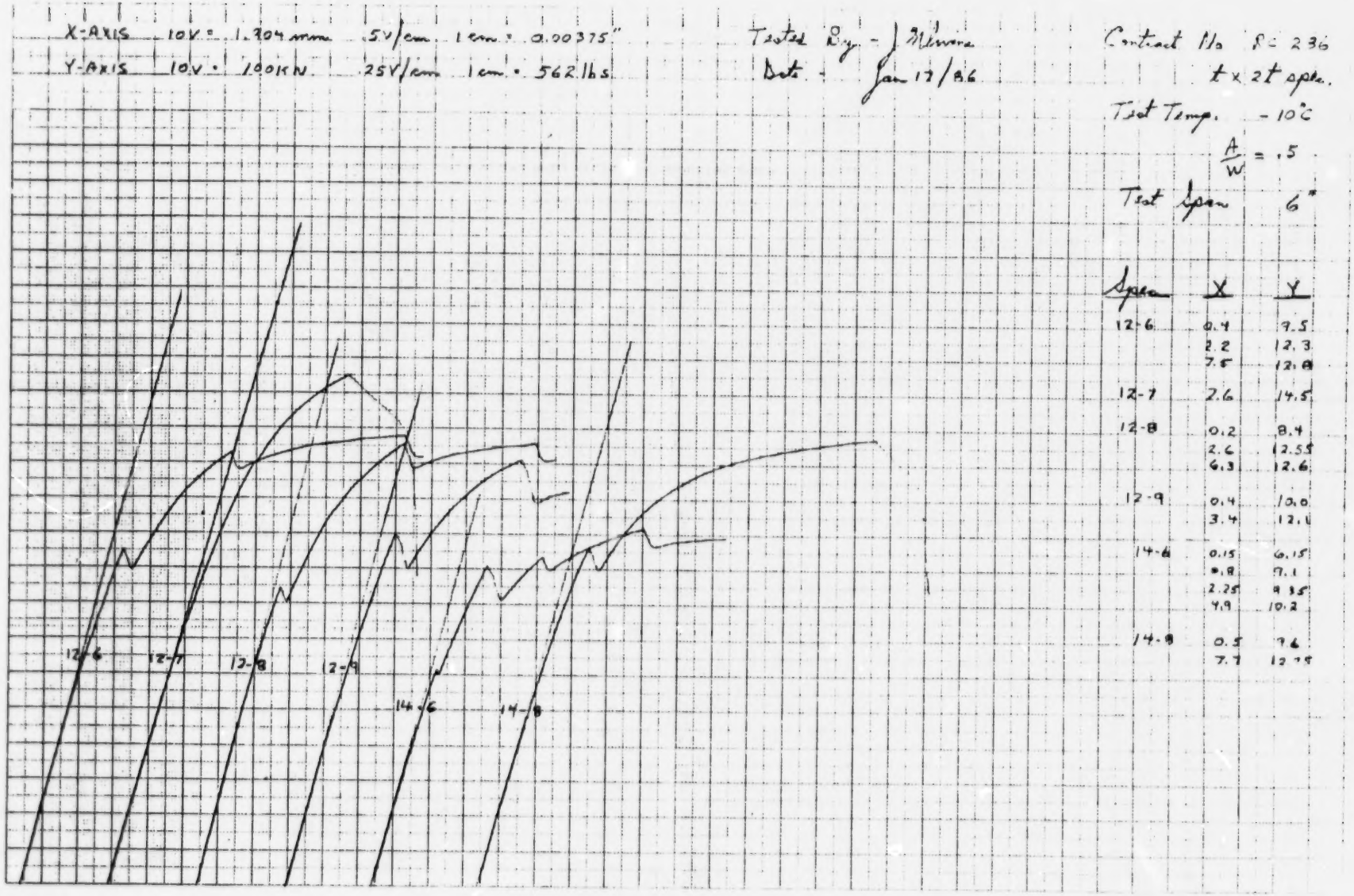
Contract No 8-236

t x 2t apls.

Test Temp. -10°C

$\frac{A}{W} = .5$

Test Span 6"



Span	X	Y
12-6	0.4	9.5
	2.2	12.3
	7.5	12.8
12-7	2.6	14.5
12-8	0.2	8.4
	2.6	12.55
	6.3	12.6
12-9	0.4	10.0
	3.4	12.1
14-6	0.15	6.15
	0.8	7.1
	2.25	9.35
	4.9	10.2
14-8	0.5	7.6
	7.7	12.9

X-AXIS 10V = 2·5mm ; CHART 0·5V = 1CM = 0·00375"

Y-AXIS 10V = 10KN ; CHART 0·25V = 1CM = 2·5KN OR 562 LBS

Tested by I on Montgomery
Feb 21 st '86

Contract # AC-286/1
T×2T Specimens
Test Temp -30°C
A/W = 0·5
Span 6·00"

SPEC.	X	Y	
16-1	0·09	5·65	Sc
	1·25	7·95	SU
16-2	2·15	13·7	SU
16-3	0·1	5·7	Sc
	0·95	7·9	SU
	1·75	9·3	SU
16-4	0·65	10·5	~~SU~~ Sc
16-5	0·95	11·55	~~SU~~ Sc
13-1	0·15	7·55	Sc
	2·25	10·7	SU
13-2	0·1	7·7	Sc
13-3	0·4	7·7	Sc
13-4	0·07	7·85	Sc
	1·75	8·6	SU
13-5	0·4	10·4	Sc

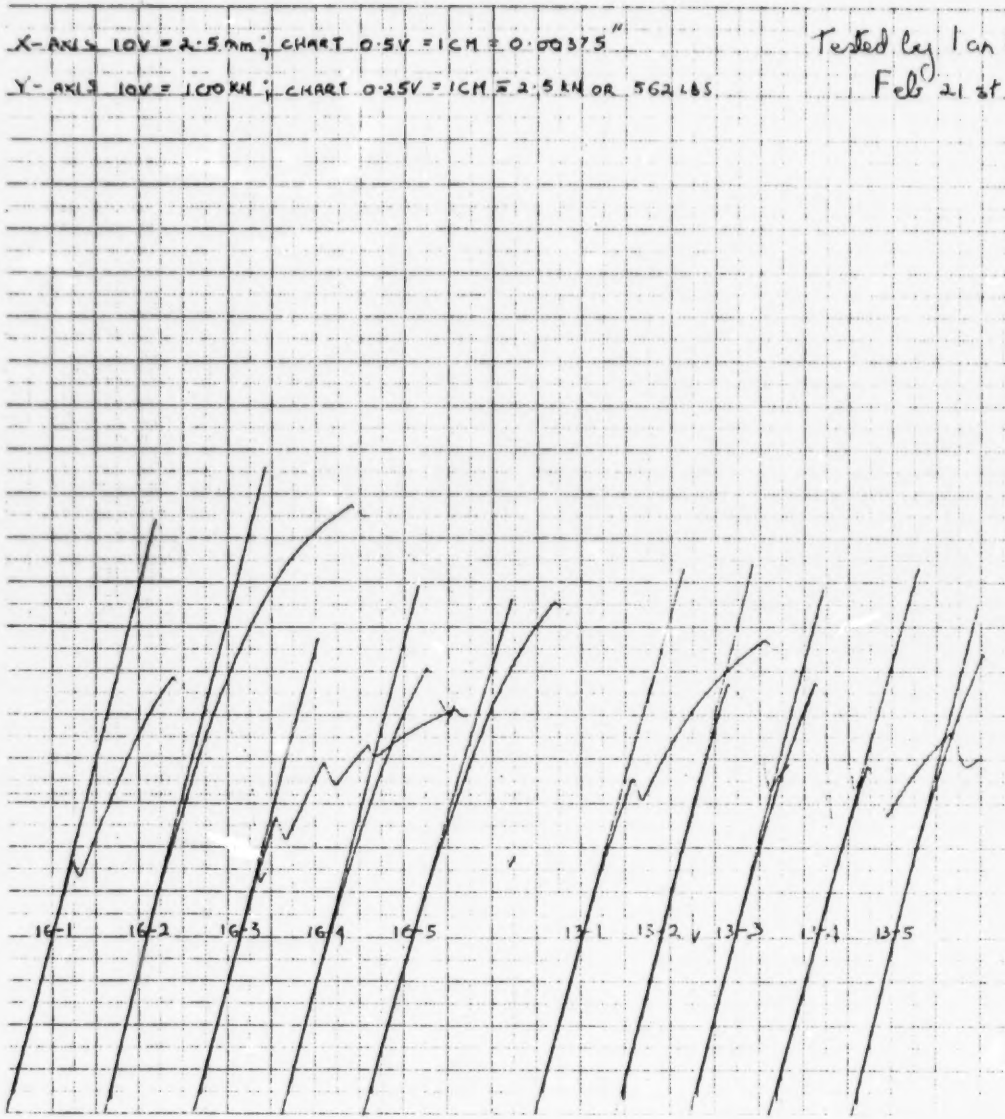


Table Fig 11

X- AXIS 10V = 2·5mm ; CHART 0·5V = 1CM = 0·0375"
Y- AXIS 10V = 100KN ; CHART 0·25V = 1CM = 2·5KN OR 562·5LBS

Tested by Ian Montgomery
26th Feb '86 Series 1-7
27th Feb " Series 1-4

Contract # RC-296/1
I & I Specimens
Test Temp −10°C
γ_w = 0·5
Span 6·00

SPEC	X	Y	
19-6	16·3	16·9	Sm
19-7	4·65	16·7	Su
19-8	14·1	17·3	Sm
19-9	5·2	14·0	Su
19-7	1·1	12·3	Sc
19-9	0·4	7·7	Sc
	1·75	11·45	Su
	4·45	12·25	Sm

19-6 19-7 19-8 19-9 19-7 19-9

X-AXIS 10V = 1.904 mm .5V/cm 1cm = 0.00375"

Y-AXIS 10V = 100kN 2.5V/cm 1cm = 562 lbs

Tested By - J. Filion

Date - Jan 17/96

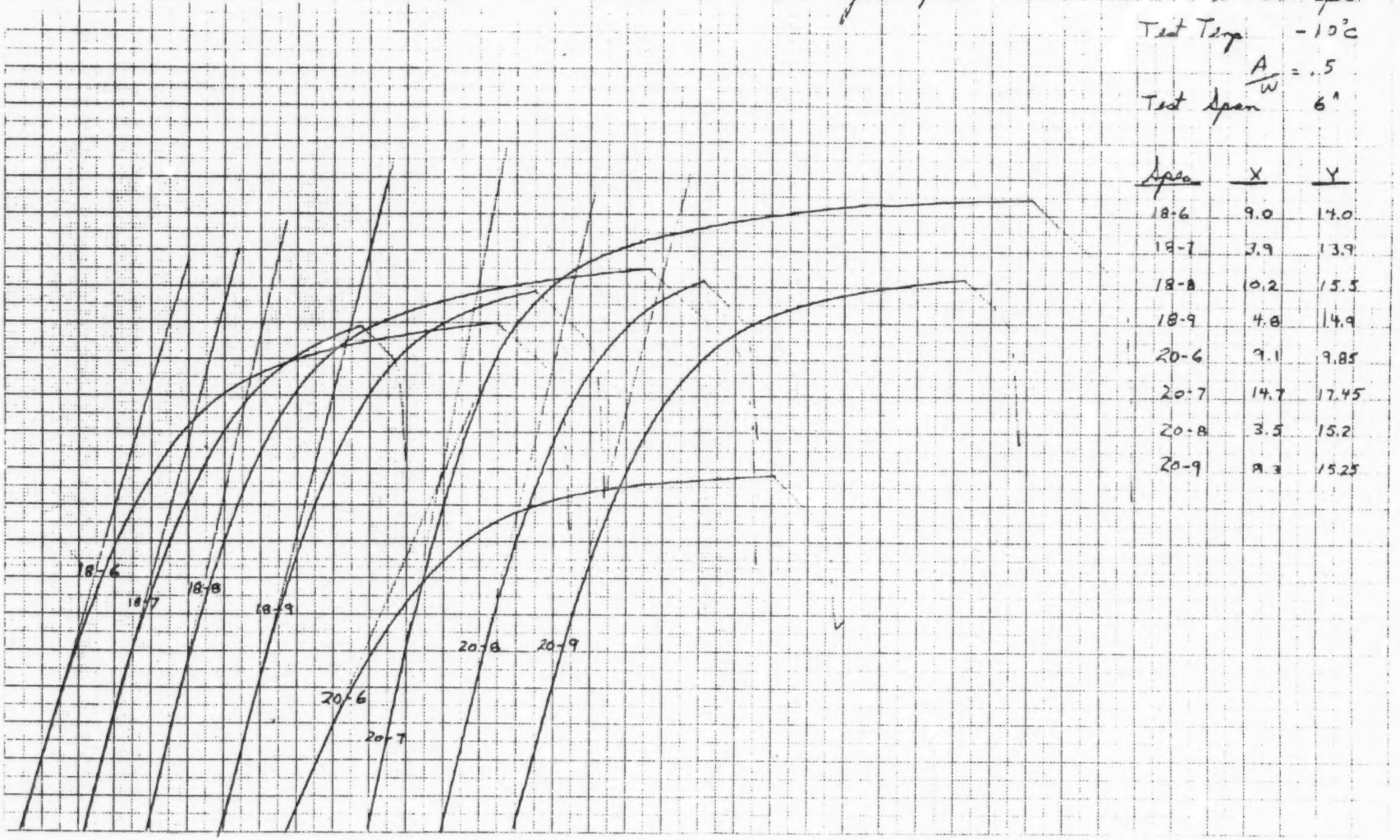
Contract No R-286

t < 2t span

Test Temp -10°C

$\frac{A}{W}$ = .5

Test Span 6"



Span	X	Y
18-6	9.0	14.0
18-7	3.9	13.9
18-8	10.2	15.5
18-9	4.8	14.9
20-6	9.1	9.85
20-7	14.7	17.45
20-8	3.5	15.2
20-9	8.3	15.25

X-AXIS 10V = 2mm ; CHART ICR = 0·5V = 0·00375"

Y-AXIS 10V = 100KN ; CHART ICM = 0·25V = 1·9KN OR 562 LBS

Tested by Tom Montgomery

Series SA-1

11th March 86

Contract RAE 2810/2

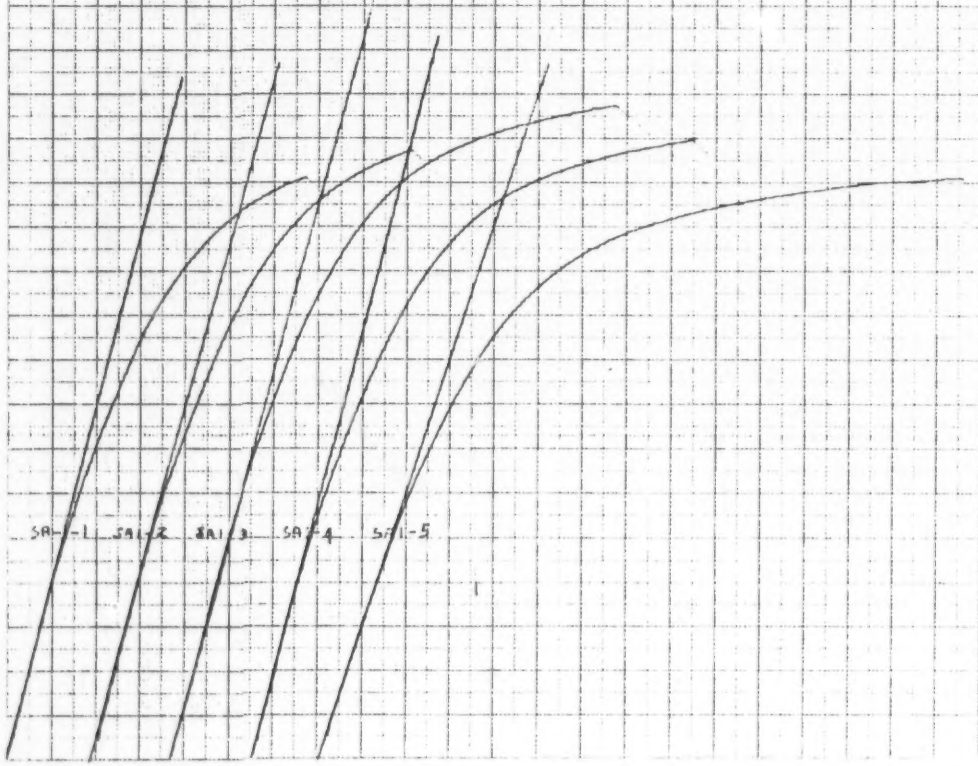
T & T Specimens

Test Temp −30°C

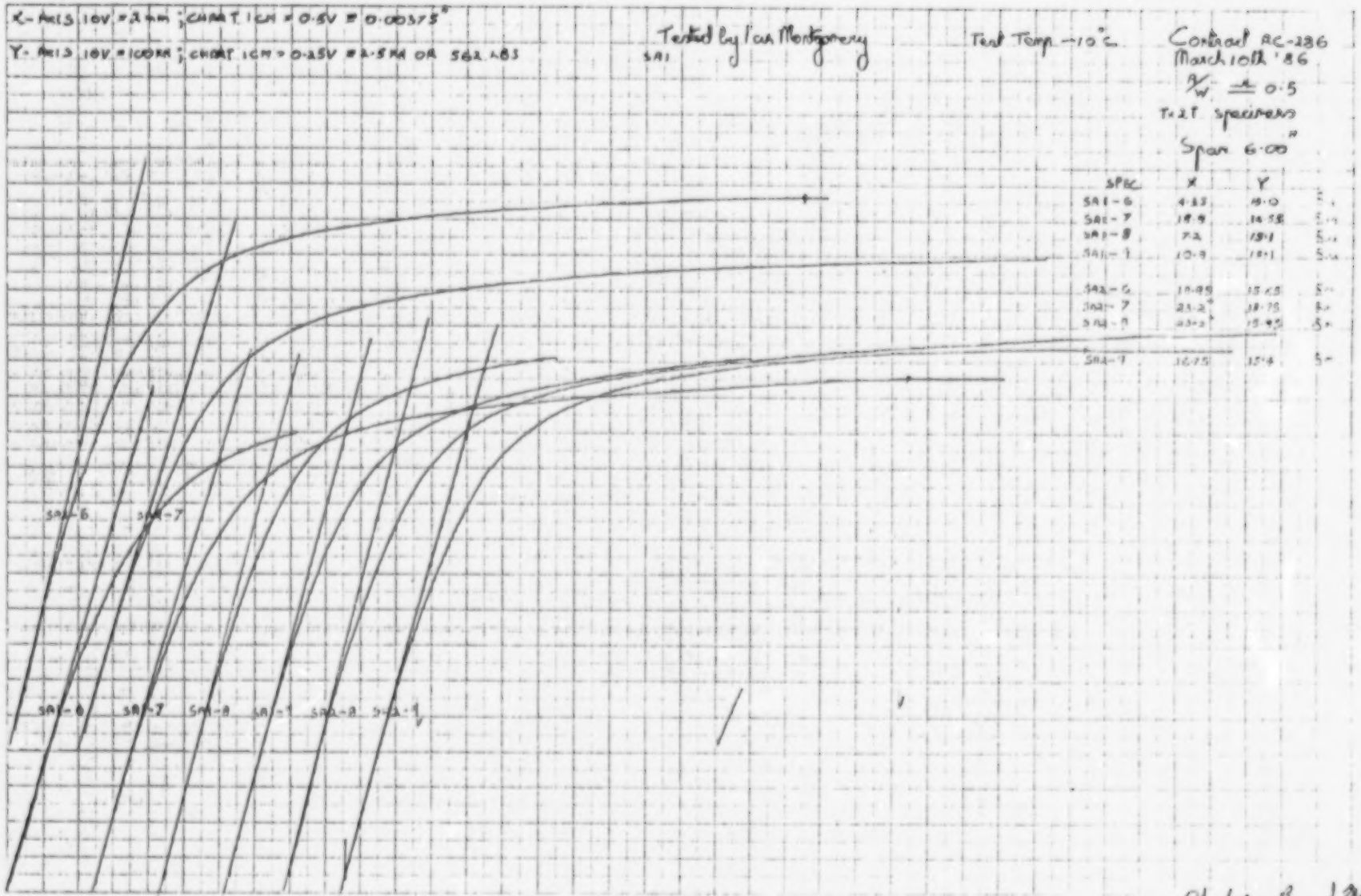
$\frac{A}{W}$ = 0·5

Span 6·00"

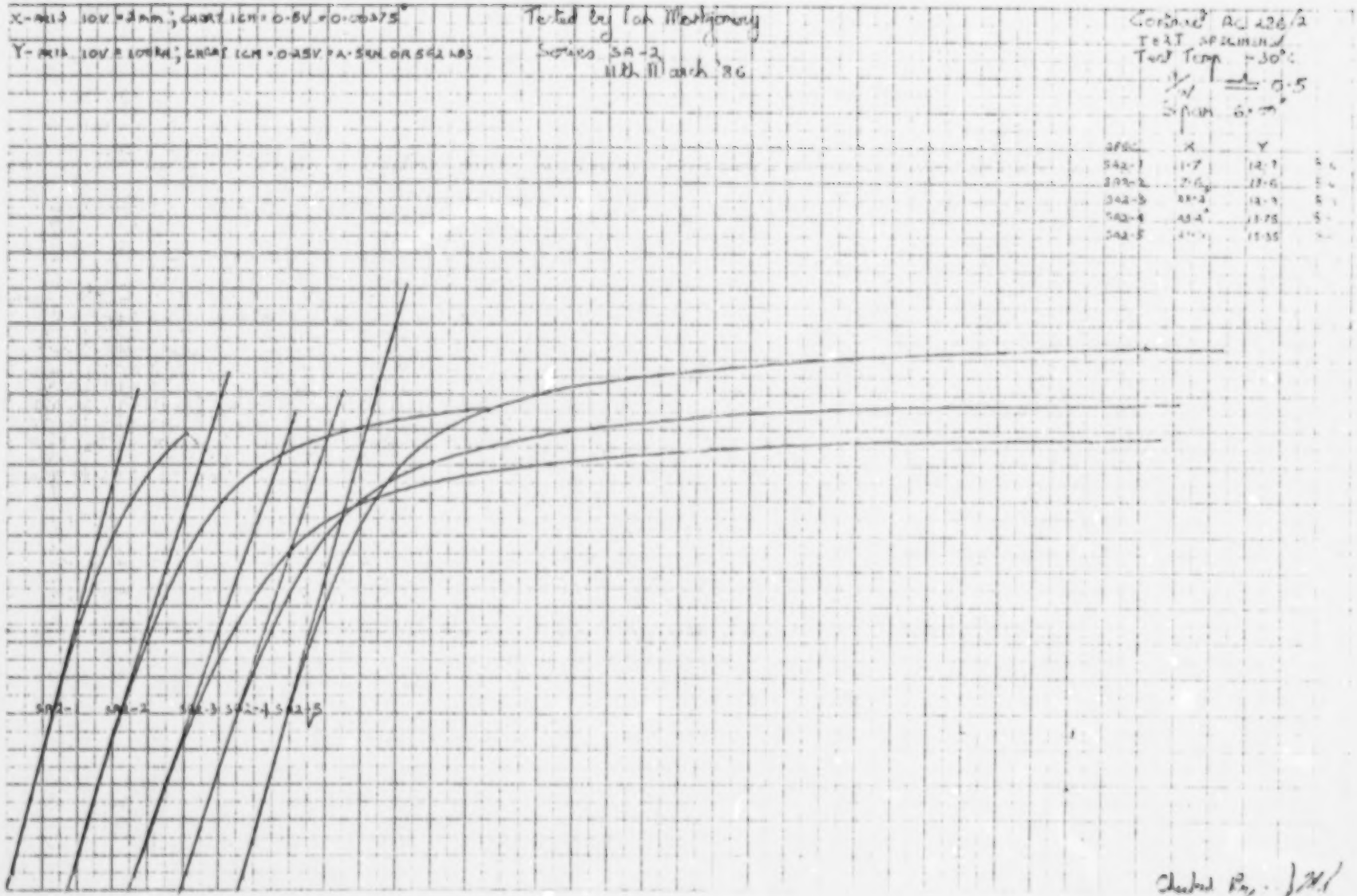
SPEC	X	Y	
SA1-1	3·35	13·1	Su
SA1-4	2·50	13·75	Su
SA1-3	6·00	14·75	Su
SA1-4	6·35	13·75	Su
SA1-5	10·2	13·1	Su



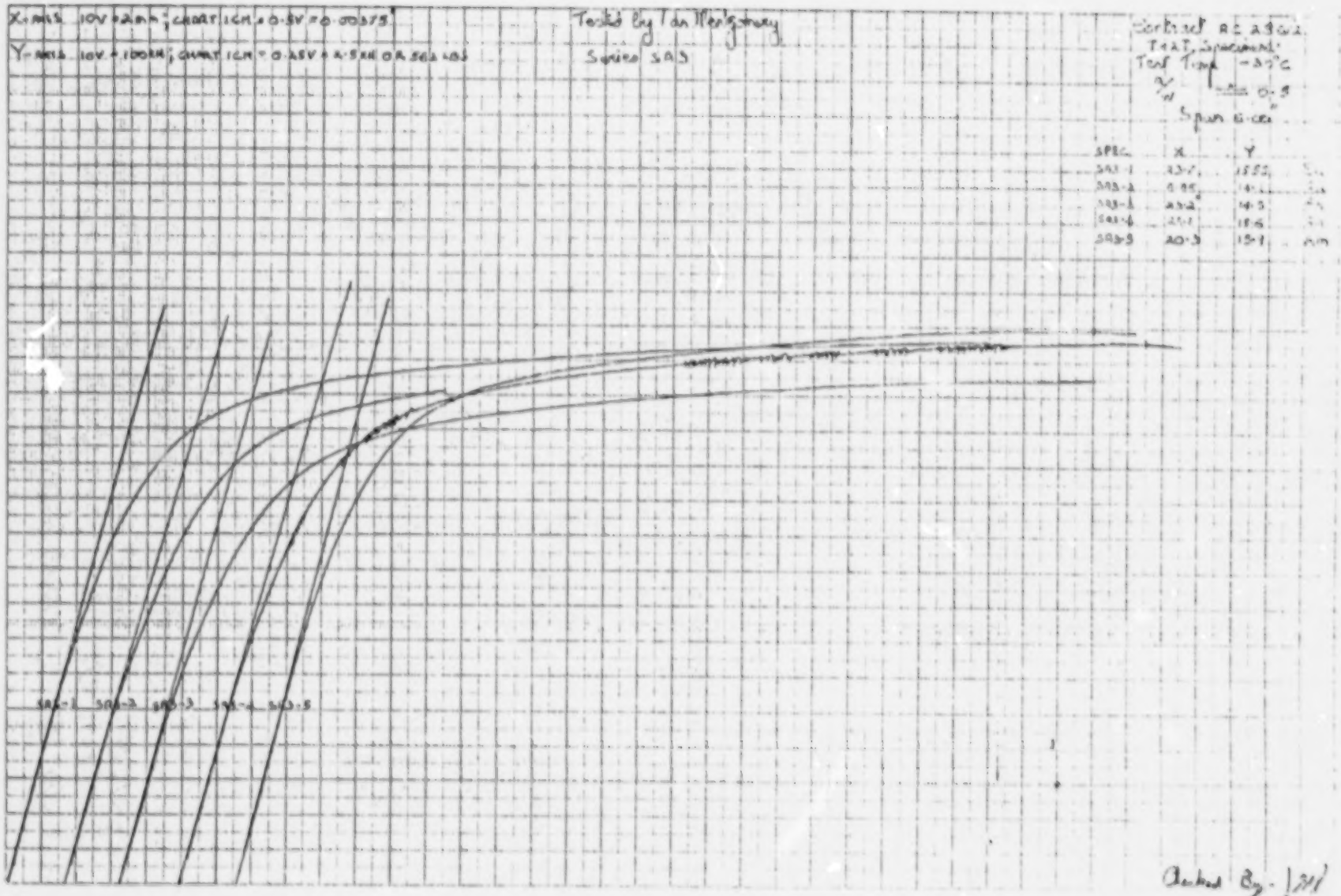
Checked By J.H.

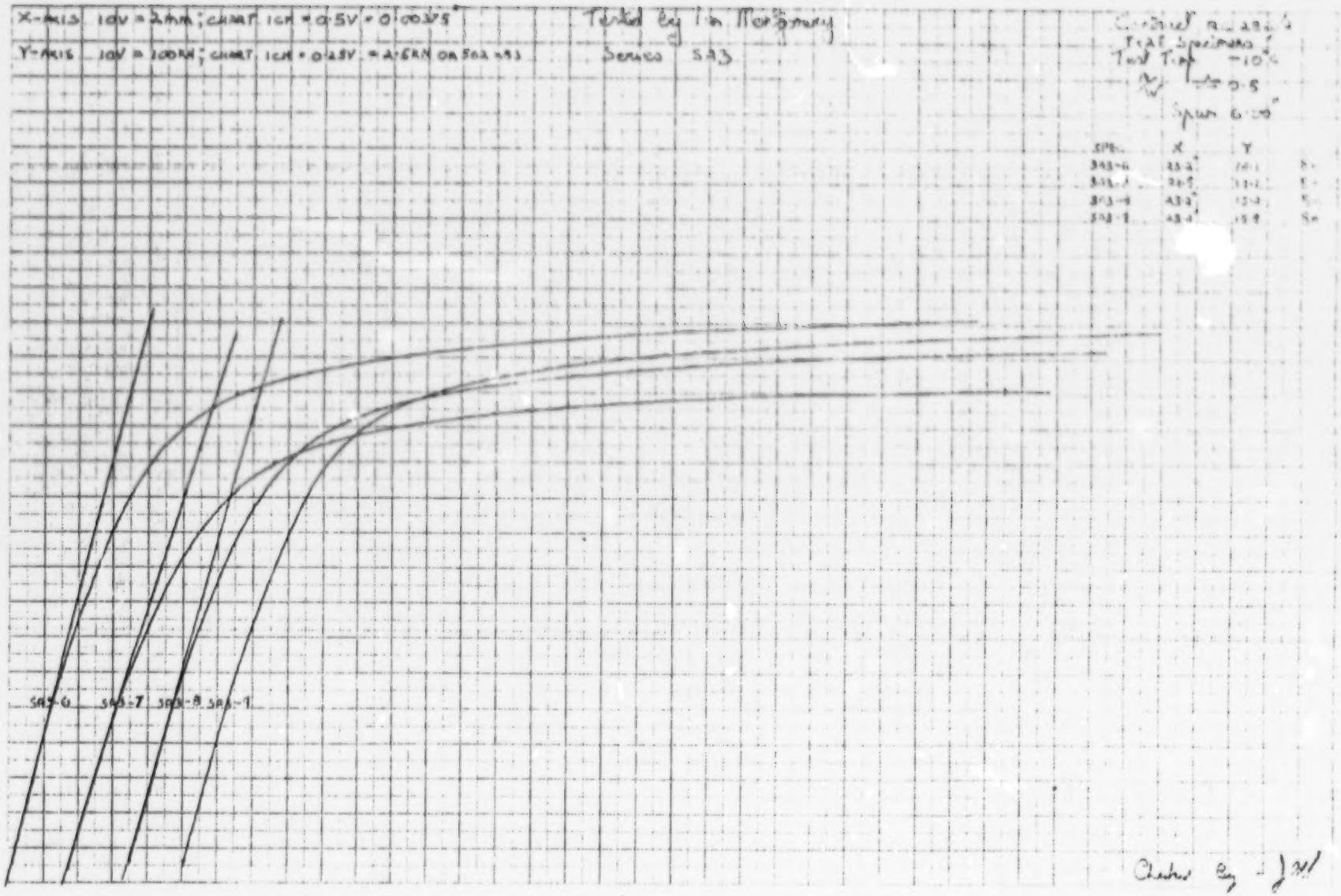


Checked By J.M.


X-axis 10V = 3mm; CHART 1CM = 0·5V = 0·0375"
Y-axis 10V = 10MM; CHART 1CM = 0·25V = A·5UN OR 5Ω LOAD
Tested by Ian Montgomery
Swiftsure SA-2
11th March '86
Constant RC 228/2
TEST SPECIMEN
Test Temp = 30°C
1/N = 0·5
Span 6·0"
SPEC X Y
542-1 11·7 12·7
542-2 11·6 13·6
542-3 11·3 13·9
542-4 11·4 13·75
542-5 11·1 13·55
542-1 542-2 542-3 542-4 542-5

Checked By J.W.I


X-axis 10V = 2cm; chart 1cm = 0.5V = 0.00375
Y-axis 10V = 100kN; chart 1cm = 0.25V = 2.5kN OR 562.5lbs
Tested by Tom Montgomery
Squires SAS
Contract RE 2502
T+T, Specimen:
Test Temp -25°C
Span 6.0cm
SPEC X Y
SAS-1 23.7 15.2
SAS-2 19.9 14.1
SAS-3 23.2 14.3
SAS-4 22.1 18.6
SAS-5 20.3 13.1
SAS-1 SAS-2 SAS-3 SAS-4 SAS-5
Tested By JM


X-AXIS 10V = 2mm; CHART 1CM = 0·5V = 0·005"
Y-AXIS 10V = 100KN; CHART 1CM = 0·25V = 2·5KN OR 500 kg
Tested by I. McSparron
Series SA3
SA3-6 SA3-7 SA3-8 SA3-1

X-AXIS 10V = 2mm ; CHART 1CM = 0·5V = 0·00375"

Y-AXIS 10V = 100KN ; CHART 1CM = 0·5V = 2·5KN OR 562 LBS

Tested by Ian Montgomery

Series SA4

Certified A/C 22.5/2

T.A.T. Specimens

Test Temp -30°C

A/W ±0·5

Span 6·00"

SPEC	X	Y	
SA4-1	1·7	12·9	F.A.
SA4-2	7·1	13·3	F.A.
SA4-3	3·3	14·15	F.A.
SA4-4	4·15	12·25	F.A.
SA4-5	5·2	13·3	F.A.

SA4-1 SA4-2 SA4-3 SA4-4 SA4-5

Checked Ry - J.W.

X- AXIS 10V = 2mm ; CHART 1CH = 0·5V = 0·005"

Y- AXIS 10V = 100KN ; CHART 1CH = 0·25V = 2·5KN OR 562 LBS

Tested by Ian Montgomery

Stores S24

Certificate AC 2362

T & I Specimens

Test Temp −10°C

At 5V = 0·5

Span 0·05"

SPEC	X	Y	
S24-6	9·25	13·5	5
S24-7	17·8	13·95	5
S24-9	20·9	15·5	5
S24-1	12·5	14·75	5

S24-6 S24-7 S24-8 S24-9

Checked By. [illegible]

X-AXIS 10V = 2mm ; .5V/cm ; 1cm = 0.0625"

Y-AXIS 10V = 10KN ; 2V/cm ; 1cm = 5KN

Tested By - J. Palmer

Series SAS

Mark 1/96

Control R = 25 ft

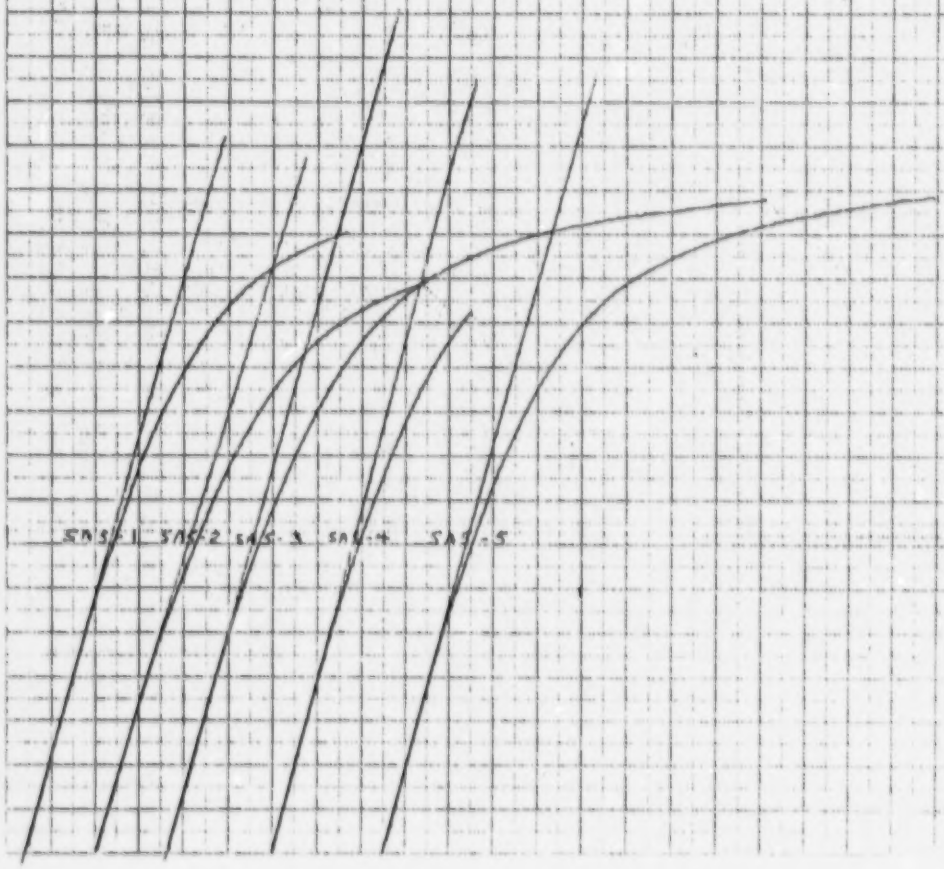
Pull 1/2 in.

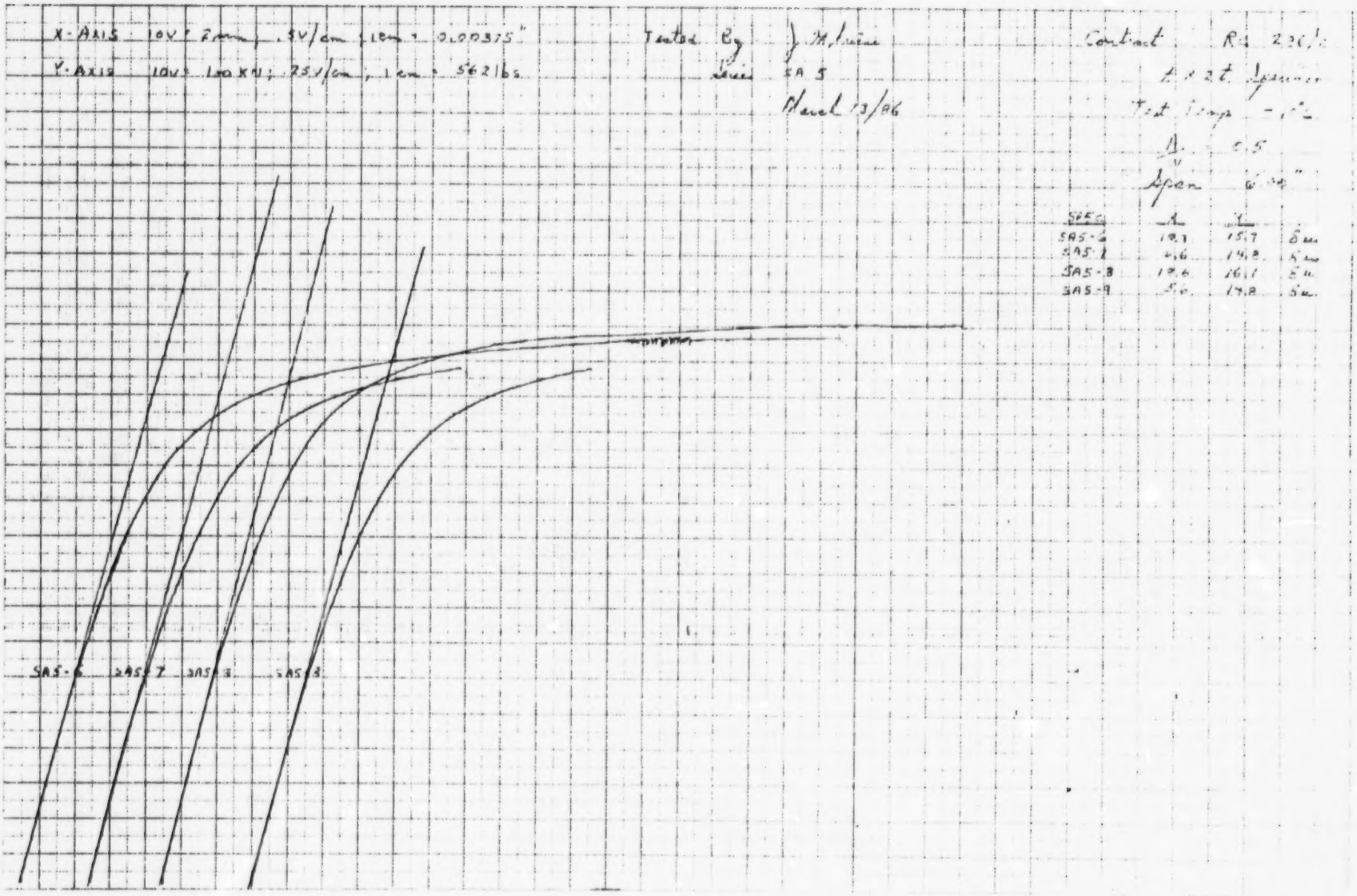
Test Temp - 3 C

R = 0.5

Span 6.0"

Spec.	X	Y	
SAS-1	3.35	14.05	Sa
SAS-2	3.5	12.7	Sa
SAS-3	3.4	14.3	Sa
SAS-4	1.35	12.2	Sa
SAS-5	3.4	14.85	Sa




X-AXIS 10V = 2cm ; .5V/cm ; 1cm = 0.00375"
Y-AXIS 10V = 100 X Ω ; 25Ω/cm ; 1cm = 562 lbs
Tested By
Date SA 5
Navel 13/A6
Contact R = 23 Ω
Δ x 2t Ipeak
Test temp - 1°C
Δ V 0.5
Span 6"
SPEC A Y
SAS-6 19.1 15.7 6 u
SAS-7 4.6 14.2 5 u
SAS-8 12.6 16.1 5 u
SAS-9 5.0 14.2 5 u
SAS-6
SAS-7
SAS-8
SAS-9

X-AXIS 10V = 2mm ; 25V/cm ; 1 cm = 0.00375"

Y-AXIS 10V = 100 KN ; 25 V/cm ; 1 cm = 562 lbs

Tested By: JPH

Date: 5-8-6

Material: 15/14

Content: Kc KC 20 J

4 x 24 Specimen

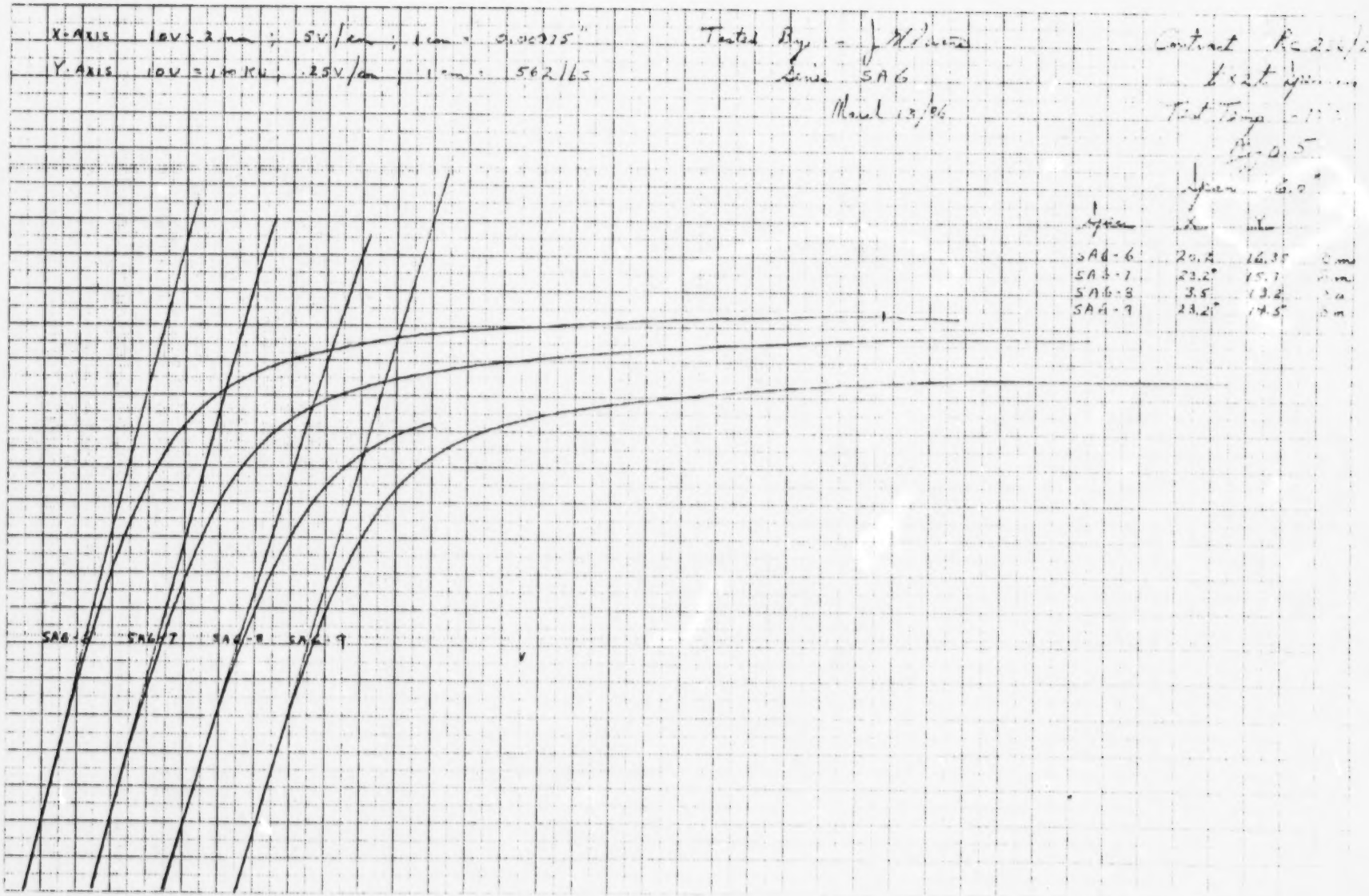
Test Temp: -50°

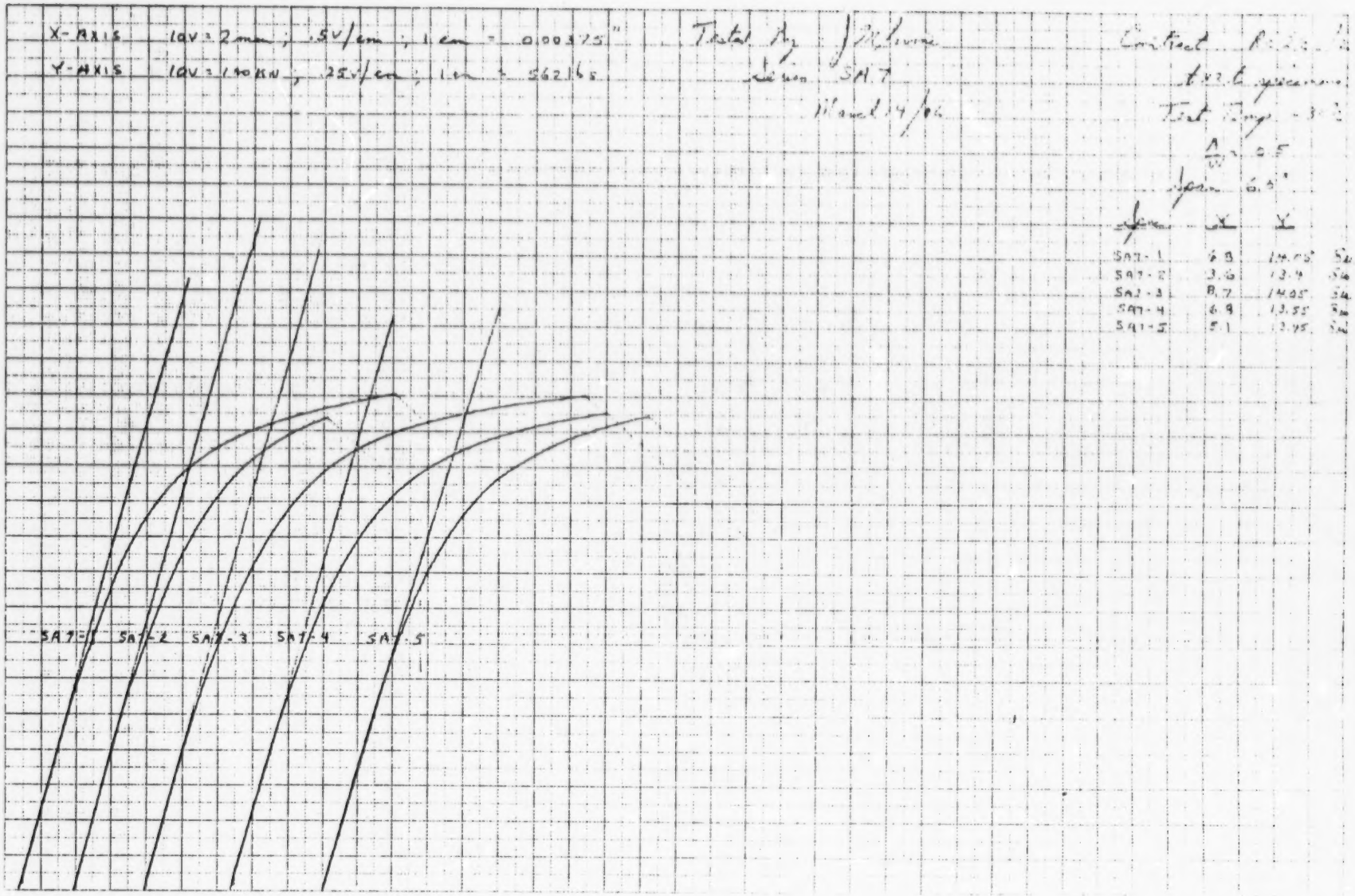
$\frac{A}{W}$ = 0.5

Span 6.0"

Spec	X	Y
SA6-1	12.95	15.4 Sa
SA6-2	12.5	15.90 Sa
SA6-3	9.7	15.25 Sa
SA6-4	12.7	14.5 Sa
SA6-5	11.5	14.92 Sa

SA6-1 SA6-2 SA6-3 SA6-4 SA6-5


X-AXIS 10V = 2 mm ; 5V/cm ; 1 cm = 0.06315"
Y-AXIS 10V = 1 mKV ; 25V/cm ; 1 cm = 562 Vs
Tested By = J. Williams
Date SA6
Mark 13/96
SA6-6 SA6-7 SA6-8 SA6-9



Total A_2 J Plume

Section SA1-1

Mould 1/4/84

Critical R

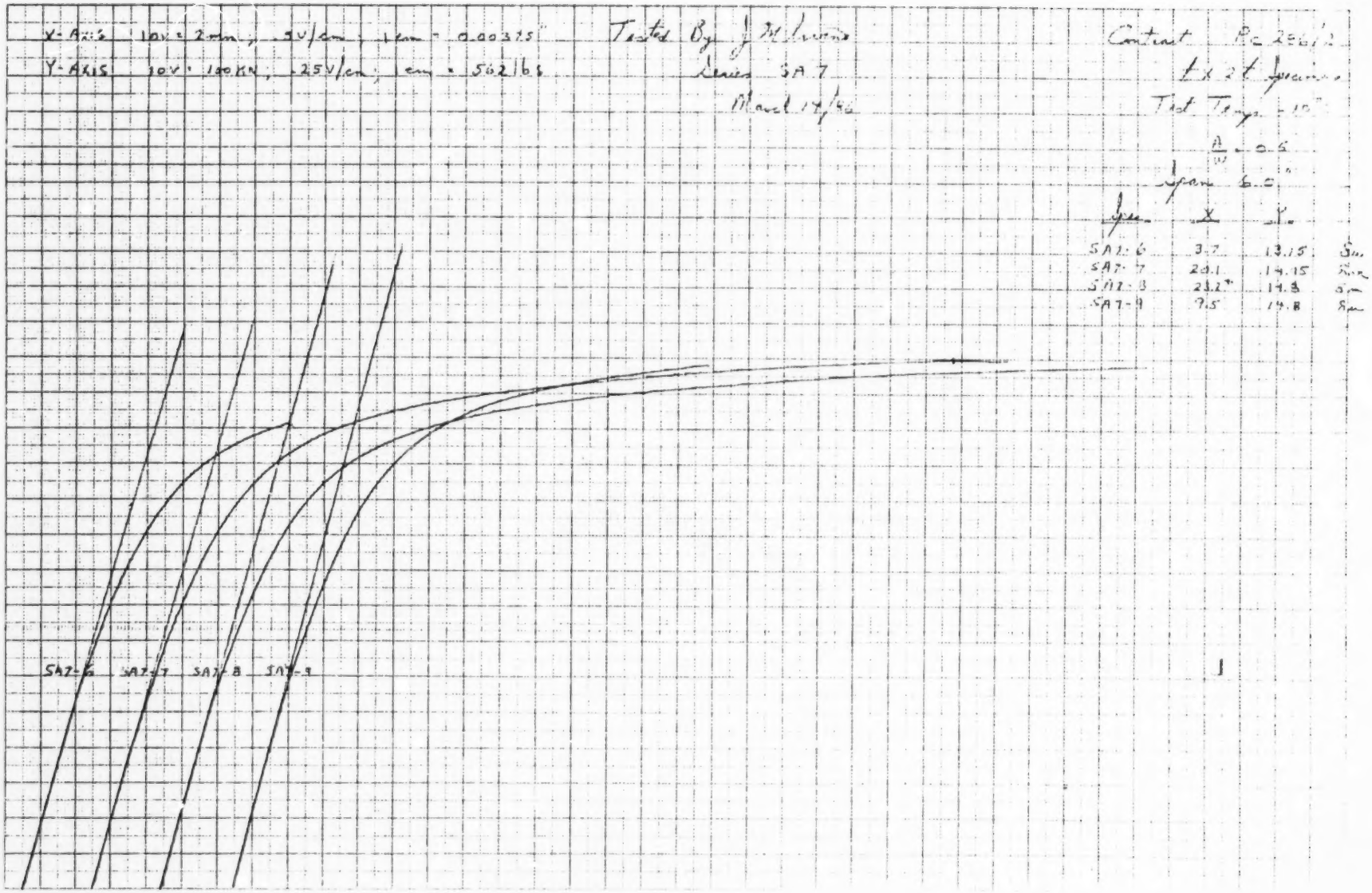
8 x 2.6 specimens

Test Temp - 3°C

$\frac{\Delta}{W} = 0.5$

$\theta_{pm} = 6.5°$

	θ_x	θ_y	
SA1-1	6.9	14.75°	SA
SA1-2	3.6	13.9	SA
SA1-3	8.7	14.05	SA
SA1-4	6.9	13.55	SA
SA1-5	5.1	13.45	SA


X-Axis 10V = 2mm, 5V/cm, 1cm = 0.00375"
Y-Axis 10V = 100Kg, 25V/cm, 1cm = 562 lbs
Tested By J. McInnis
Series SA 7
March 14/62
Contract Pc 2560/2
4 x 2 4 Specimens
Test Temp. - 15°
A/W = 0.6
Span 6.0"
Spec. X Y
SA7-6 3.7 13.15 Sm
SA7-7 20.1 14.15 Sm
SA7-8 23.2" 14.8 Sm
SA7-9 9.5 14.8 Sm
SA7-6 SA7-7 SA7-8 SA7-9

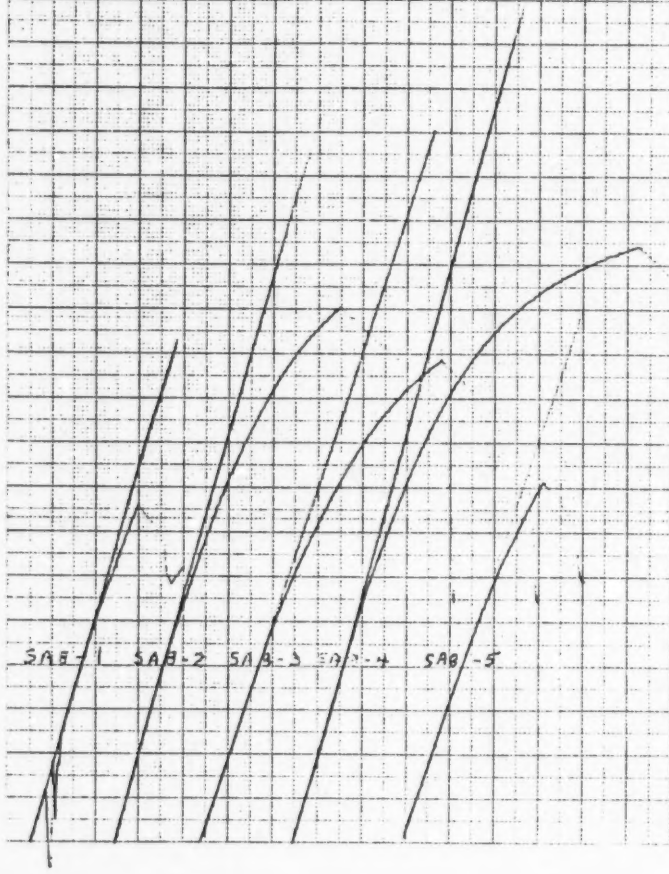
X-AXIS 10V = 2 mm ; .5V/cm ; 1 cm = 0.00375"

Y-AXIS 10V = 10 KIP ; 25V/cm ; 1 cm = 5+2 kips

Tested By J. N. Lewis
Lewis SAB
March 14/26

Contact Rc = 1/2
6 x 2 spec.
Test Temp -
L = 3.5
Span 6.0"

Spec.	X	Y	
SAB-1	0.25	7.6	Su
SAB-2	1.7	12.0	Su
SAB-3	1.9	10.95	Su
SAB-4	4.1	13.4	Su
SAB-5	0.45	8.15	Su



X-AXIS 10V = 2 mm ; .5V/cm ; 1cm = 0.00375"

Y-AXIS 10V = 100 KN ; .25 V/cm ; 1cm = 562.16

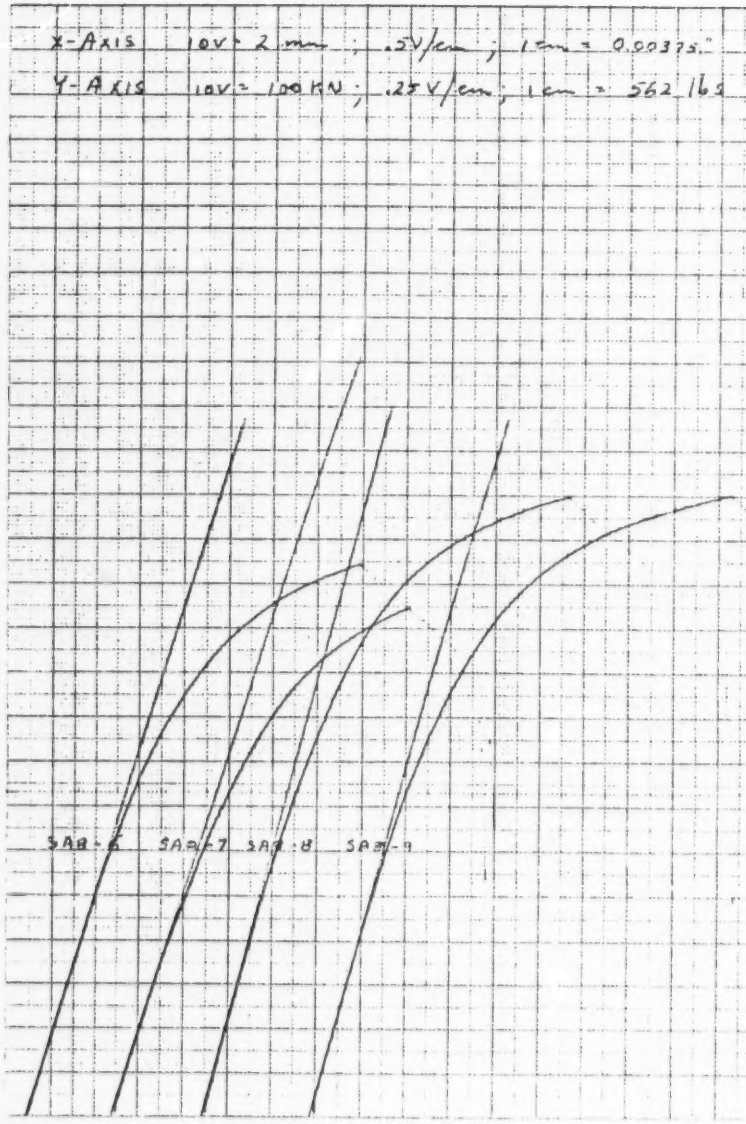
Tested By J.M. Irvine
Series SAB
March 14/86

Content R = 2.0 %
4 x 2 t Specimens
Test Temp -10°C

$\frac{A_w}{s} = 0.5$

Span 6.0"

Type	X	Y	
SAB-6	3.6	12.45	S_w
SAB-7	3.0	11.5	S_w
SAB-8	4.55	14.0	S_w
SAB-9	5.5	14.0	S_w



X- Axis 10V = 2 mm ; 25 V/cm ; 1 cm = 0.03875"

Y- Axis 10V = 100 KV ; 25 V/cm ; 1 cm = 562 lbs

Tested By J. Williams

Series SA 4

March 19/66

Contact P = 22 g

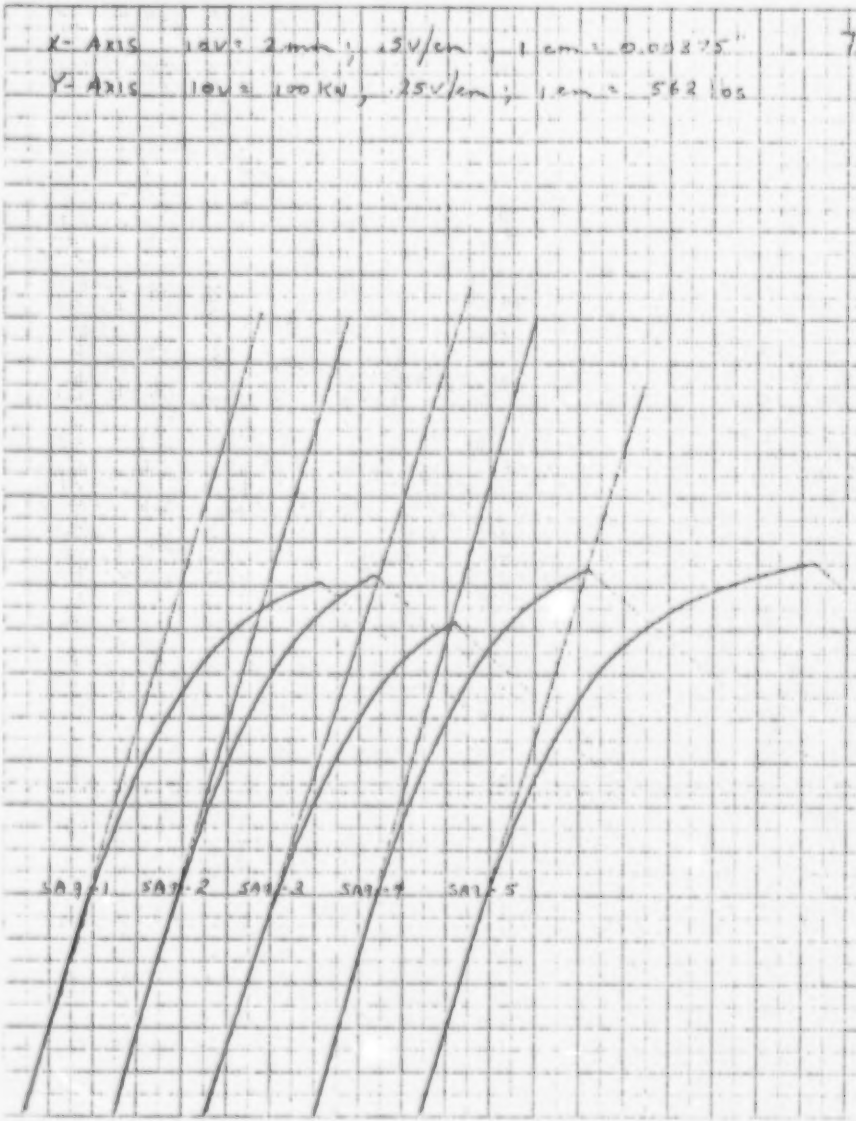
2 x 2 L - specimens

Test Temp - 3°

R = 0.5

W

Span 6.0"



Specn	L	Y	
SA4-1	3.1	12.1	1 m
SA4-2	2.3	12.25	1 m
SA4-3	2.05	11.15	1 m
SA4-4	2.75	12.4	1 m
SA4-5	5.05	12.55	1 m

X- Axis 10V = 2 cm ; 5V/cm ; 1 cm = 0.0375"

Y- Axis 10V = 10 KN = 25V/cm ; 1 cm = 562 lbs

Tested By J. Kelsen

Series SA1-9

Mould 19/26

Cut out X = 2.6 / 2

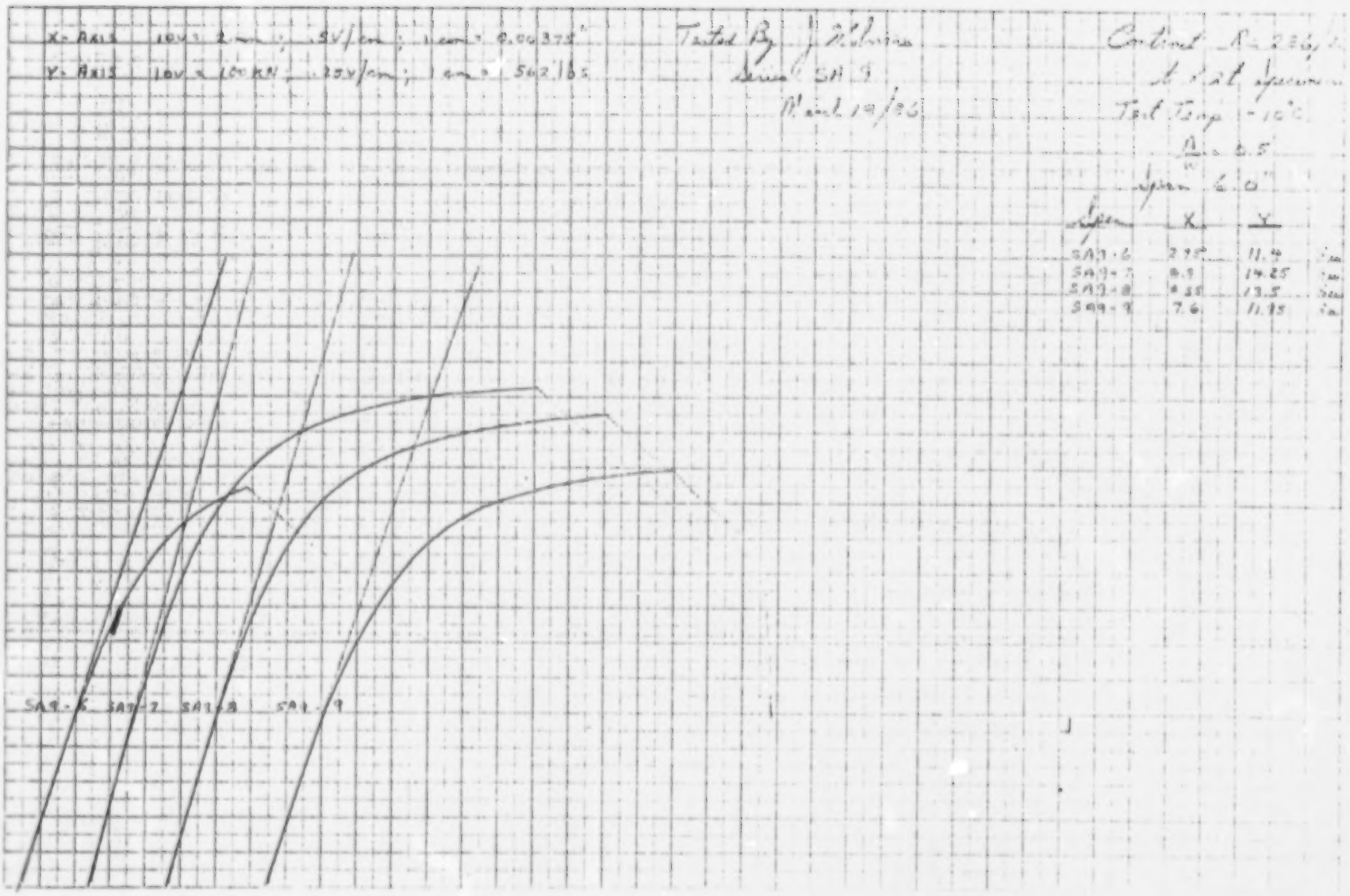
Actual specimen

Test Temp -10°C

D = 6.5"

Span 6.0"

Spec	X	Y	
SA9-6	2.95	11.4	Im
SA9-7	3.9	14.25	Im
SA9-8	4.55	13.5	Sem
SA9-9	7.6	11.15	Im



X- AXIS 10V = 2 cm ; 5V/cm ; 1cm = 0.0375"

Y- AXIS 10V = 100KN ; 25V/cm ; 1cm = 562 lbs

Tested By J.M. Irwin

Series SA10

March 17/86

Contract Ref 24 /

1 x 2 Specimens

Test Temp +3°

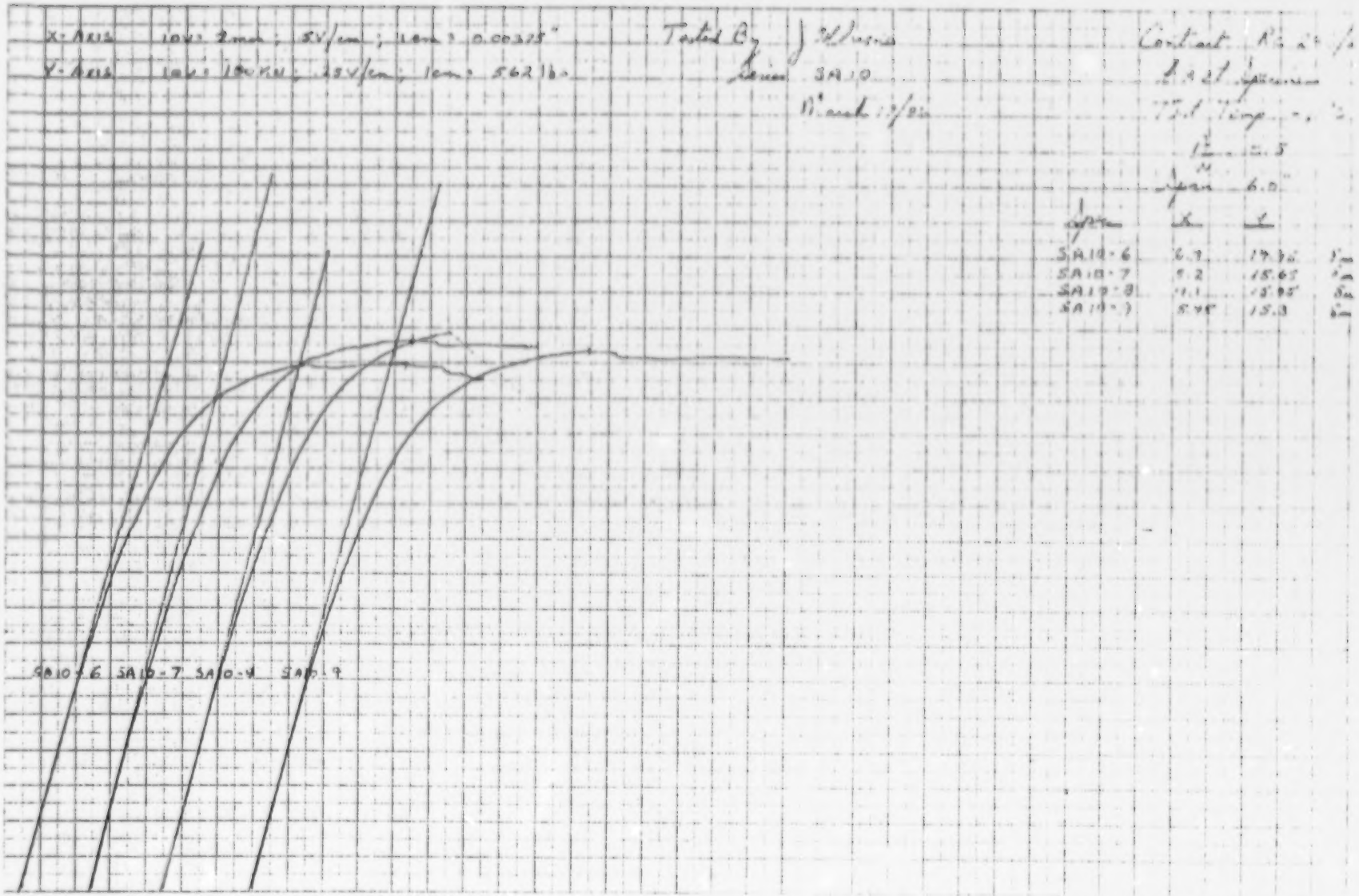
A 0.5

N

Span 6.0"

Span	X	Y	
SA10-1	1.8	14.3	δm
SA10-2	5.3	15.7	δm
SA10-3	7.3	15.75	δm
SA10-4	3.05	15.75	δm
SA10-5	2.7	15.3	δm

SA10-1 SA10-2 SA10-3 SA10-4 SA10-5


X-Axis 10V = 2mm ; 5V/cm ; 1cm = 0.00375"
Y-Axis 10V = 100 KN ; 25V/cm ; 1cm = 5621 lbs
Tested By
Series SA10
SA10-6 SA10-7 SA10-4 SA10-9
Coolant
Span 6.0"
SA10-6 6.9 19.3k
SA10-7 9.2 15.65
SA10-8 11.1 15.95
SA10-9 5.45 15.3

X-Axis 10V = 2mm ; 5V/cm ; 1cm = 0.00375"

Y-Axis 10V = 100LBS ; .25V/cm ; 1cm = 5+2 lbs

Tested By J. Helms

Date 5A11

March 7/65

Contact Pc to Pc

4 x 24 Inches

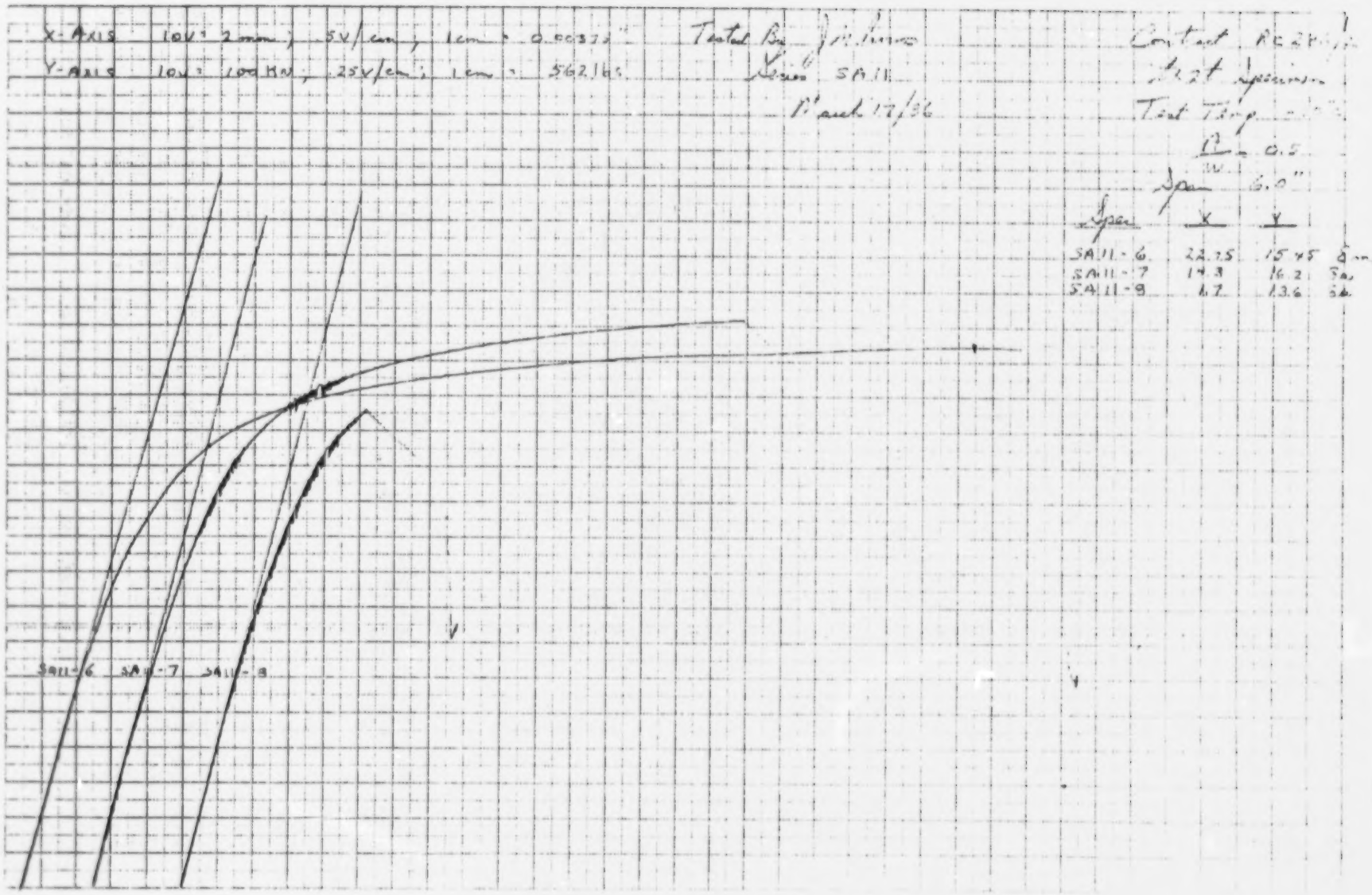
Test Type - 3 Pt

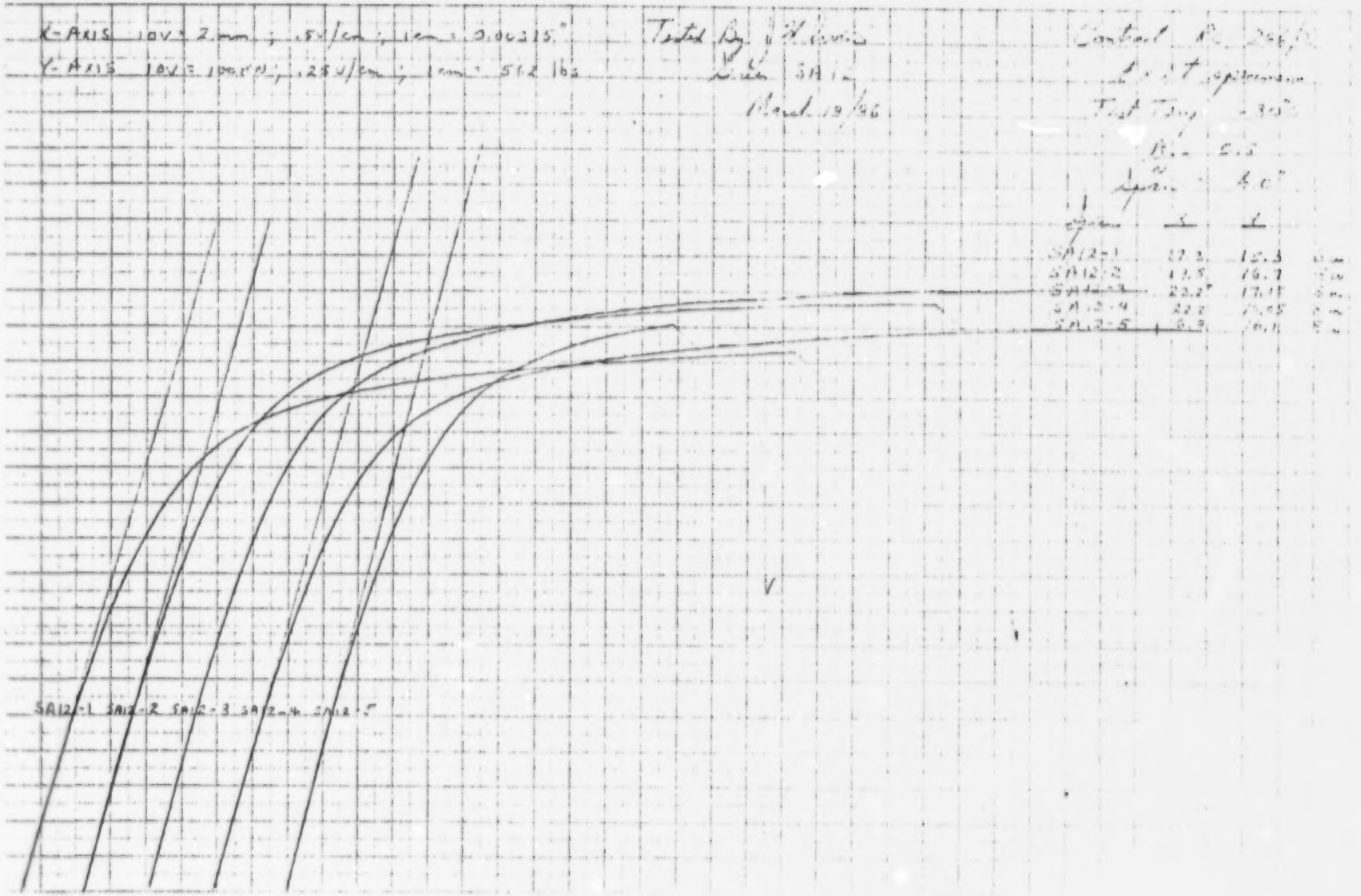
$\frac{19}{16}$ - 0.5

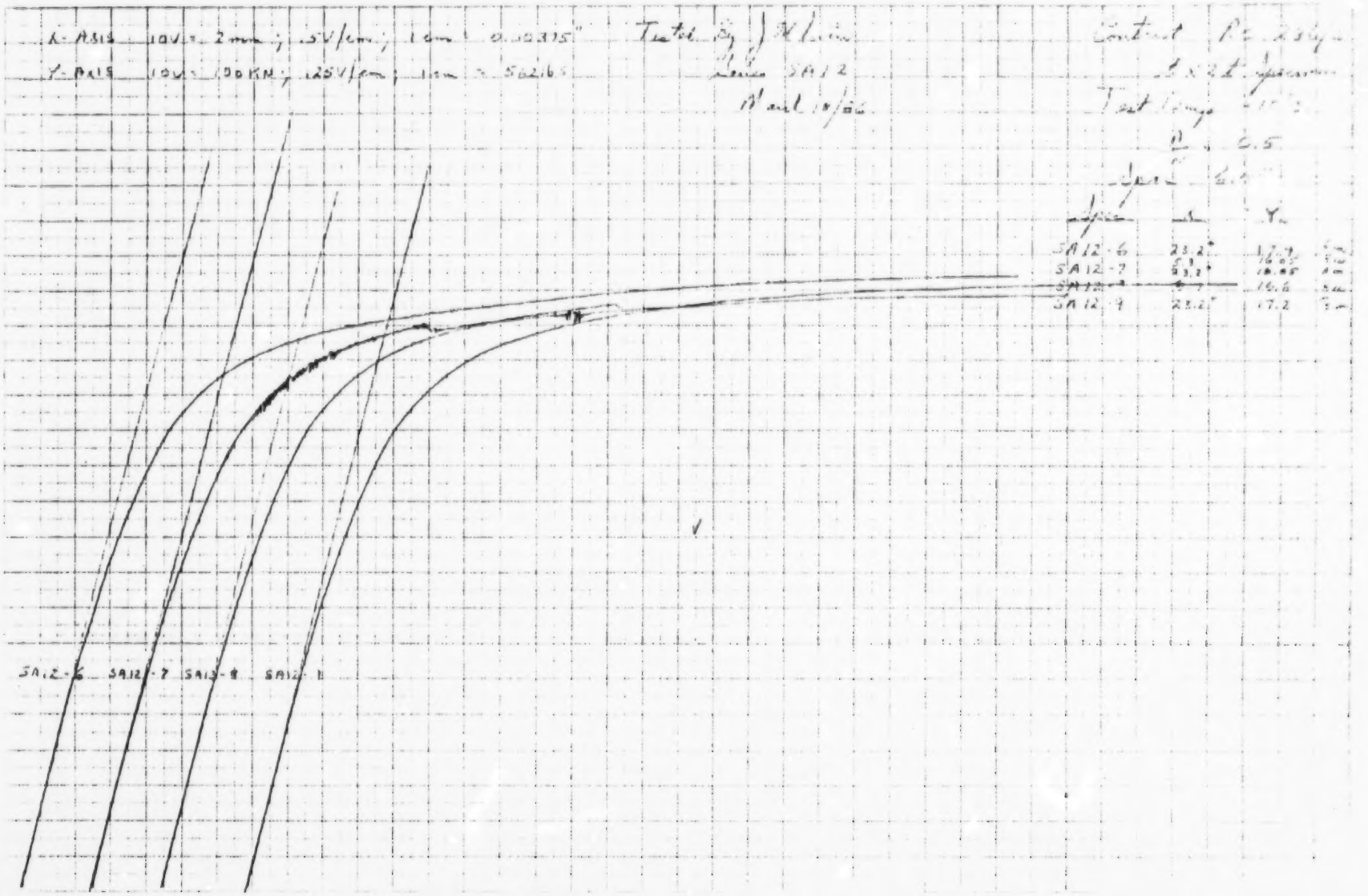
1 span 5.0"

Type	X	Y	
SA11-1	8.2	15.1	5 lbs
SA11-2	3.15	13.7	5 lbs
SA11-3	5.8	12.45	5 lbs
SA11-4	7.5	15.13	5 lbs
SA11-5	1.6	14.0	5 lbs

SA11-1 SA11-2 SA11-3 SA11-4 SA11-5


X-AXIS 10V = 2mm ; 5V/cm ; 1cm = 0.5037"
Y-AXIS 10V = 100 KN ; 25V/cm ; 1cm = 562 lbs
Tested By
Date Tested
Series SA II
Batch 17/36
Contact Area
Test Specimens
Test Temp
a/d = 0.5
Span 6.0"
Type X Y
SA II-6 22.75 15.45 Sq.
SA II-7 14.3 16.2 Sq.
SA II-8 11.7 13.6 Sq.
SA II-6
SA II-7
SA II-8


K-AXIS 10V = 2 mm ; .5 V/cm ; 1 cm = 0.0625"
Y-AXIS 10V = 10 mm ; 2.5 V/cm ; 1 cm = 5.2 lbs
Tested By
Mark 19/36
SA12-1 SA12-2 SA12-3 SA12-4 SA12-5
V


X- ASIS 10V = 2mm ; .5V/cm ; 1cm = 0.0315"
Y- PAIS 10V = 100KN ; 125V/cm ; 1cm = 5a2.6
Tested by J.K.Lee
Series SA12
Mark 10/66
Control Pc 28 day
3 x 12" specimens
Test temp 21°C
D = 6.5
Spec = 6.4
SA12-6 23.2° 17.9
SA12-7 53.1° 16.05
SA12-8 ? 16.6
SA12-9 23.2° 17.2
SA12-6 SA12-7 SA12-8 SA12-9